# Public Health Reports

VOLUME 54 JUNE 16, 1939 NUMBER 24

## IN THIS ISSUE

The Present Poliomyelitis Situation No Cause for Alarm

Skin Tests and Serum Antibodies in Pneumonia Immunity

Use of Chick Embryo in Preparing Spotted Fever Vaccine

Preserving Encephalitis Viruses by Freezing and Drying

Summary of Vital Statistics for the United States, 1937

UNITED STATES PUBLIC HEALTH SERVICE

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# Public Health Reports

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## POLIOMYELITIS IN THE UNITED STATES

With the tourist season in full swing, widespread interest in the possible danger from poliomyelitis has been manifested in numerous inquiries to the Public Health Service and to State and local health departments.

A study of the distribution of this disease since January 1939 shows that the incidence of poliomyelitis remained lower than the expectancy, according to the 5-year median, throughout the United States until the recent outbreak in South Carolina. At the present time the condition is apparently on the decline in South Carolina and nowhere else is poliomyelitis sufficiently prevalent to cause alarm.

For the week ended June 10, 1939, there were 54 cases of poliomyelitis reported from the entire country as compared with 60 cases for the preceding week and with 38 cases for corresponding weeks of the 1934–38 period.

## VITAL STATISTICS SUMMARY FOR THE UNITED STATES 1937

A summary of the final tabulation of natality and mortality figures for 1937, from the Bureau of the Census, Department of Commerce, was published in the Public Health Reports for January 20, 1939, and provisional figures for 1938 appeared in the Public Health Reports for February 17, 1939. In a recent report [1] the Census Bureau presented a summary of the data for 1937 by race and sex and by States, according to place of residence, and a brief interesting analysis on the basis of other factors. As the tabulation of these data by residence has only recently been begun by the Census Bureau, and as, in some instances, the reassignment of the figures on this basis may affect the rates, the tabulations are presented here as of special value to health officers and other persons interested in vital statistics.

Table 1 summarizes the natality and mortality data for the 11-year period 1927–37, and the accompanying chart shows graphically the trends in the birth and death rates during that period. In 1937 there was a net natural increase of 5.8 per 1,000 population; but, as is well known by students of population, the excess of the crude birth rate over the crude death rate does not give an accurate index to the *future* natural growth of our population. Both the birth rate and the death

[1] Vital Statistics—Special Reports, vol. 6, No. 57, April 29, 1939.

rate are affected by the age distribution of the people, and this is undergoing a change with a shift toward the older age groups. This change, for biological reasons, will tend to produce a continued reduction in the birth rate and it will operate to check any further great reduction in the general death rate.

It is of interest to note the continued decrease in the infant mortality rate, which was 68.7 in 1928, 57.1 in 1936, and 54.4 in 1937.

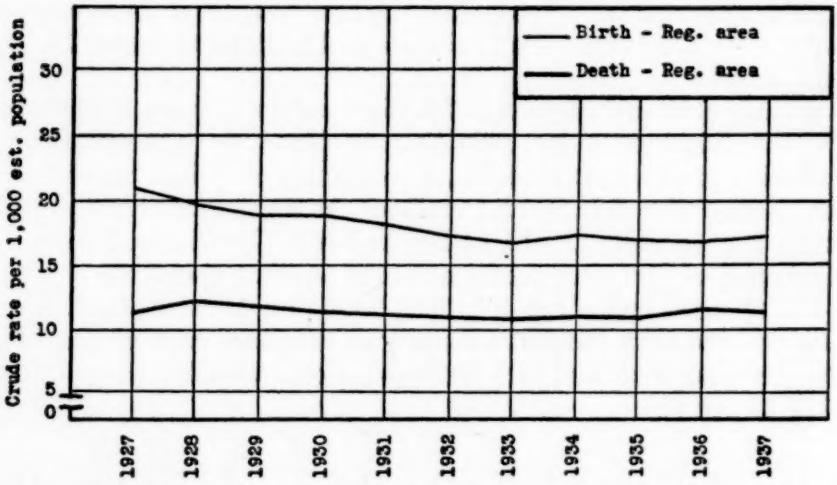


FIGURE 1.—Crude birth and death rate trends in the United States registration areas, 1927-37.

The continued lowering of this rate may tend to retard the approach to a stabilized population and, of course, it contributes to the increasing life expectancy at birth.

TABLE 1.—*Summary of vital statistics data for the registration areas of the United States, 1927–37*

| Year | Percent of total population in registration areas | | Number | | Crude rate (number per 1,000 estimated population) | | Births per 100 deaths | Death rate (number per 1,000 live births) | | Death rate (number per 100,000 estimated population) | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Birth | Death | Births | Deaths | Births | Deaths | | Infant mortality | Maternal mortality | Tuberculosis | Cancer | Motor vehicle accidents |
| 1937 | 100.0 | 100.0 | 2,203,337 | 1,450,427 | 17.0 | 11.2 | 152 | 54.4 | 4.9 | 53.6 | 112.0 | 30.7 |
| 1936 | 100.0 | 100.0 | 2,144,790 | 1,479,228 | 16.7 | 11.5 | 145 | 57.1 | 5.7 | 55.7 | 111.0 | 29.7 |
| 1935 | 100.0 | 100.0 | 2,155,105 | 1,392,752 | 16.9 | 10.9 | 155 | 55.7 | 5.8 | 55.0 | 107.9 | 28.5 |
| 1934 | 100.0 | 100.0 | 2,167,636 | 1,396,903 | 17.1 | 11.0 | 155 | 60.1 | 5.9 | 56.6 | 106.2 | 28.5 |
| 1933 | 100.0 | 100.0 | 2,081,232 | 1,342,106 | 16.5 | 10.7 | 155 | 58.1 | 6.2 | 59.5 | 102.2 | 24.9 |
| 1932 | 95.2 | 96.3 | 2,074,042 | 1,308,529 | 17.4 | 10.9 | 159 | 57.6 | 6.3 | 62.8 | 102.0 | 23.6 |
| 1931 | 94.7 | 96.3 | 2,112,760 | 1,322,587 | 18.0 | 11.1 | 160 | 61.6 | 6.6 | 68.1 | 98.9 | 27.1 |
| 1930 | 94.7 | 96.2 | 2,203,958 | 1,343,356 | 18.9 | 11.3 | 164 | 64.6 | 6.7 | 71.5 | 97.3 | 26.7 |
| 1929 | 94.7 | 95.7 | 2,169,920 | 1,386,363 | 18.9 | 11.9 | 157 | 67.6 | 7.0 | 76.0 | 95.9 | 25.7 |
| 1928 | 94.3 | 95.3 | 2,233,149 | 1,378,675 | 19.8 | 12.1 | 162 | 68.7 | 6.9 | 79.3 | 96.1 | 23.4 |
| 1927 | 87.6 | 91.5 | 2,137,836 | 1,236,949 | 20.6 | 11.4 | 173 | 64.6 | 6.5 | 80.9 | 95.7 | 21.8 |

TABLE 2.—*Number of births, deaths, and infant deaths (under 1 year of age), by race and sex, United States, 1937*

| | Total | White | | Negro | | Other races | |
|---|---|---|---|---|---|---|---|
| | | Male | Female | Male | Female | Male | Female |
| Births | 2,203,337 | 991,356 | 937,081 | 132,990 | 129,472 | 6,295 | 6,143 |
| Deaths | 1,450,427 | 702,630 | 552,157 | 101,166 | 86,428 | 5,038 | 3,008 |
| Infant deaths | 119,931 | 55,505 | 41,559 | 11,920 | 9,593 | 748 | 606 |

TABLE 3.—*Number of deaths, according to place of residence, in the United States, 1937*

| Area | Total deaths in area | Deaths— | | | | | | Total deaths of residents |
|---|---|---|---|---|---|---|---|---|
| | | Of nonresidents in area | | | Of residents in other areas | | | |
| | | Total | From same State | From other States | Total | In same State | In other States | |
| United States | 1,450,427 | 179,874 | 151,264 | 28,610 | 179,874 | 151,264 | 28,610 | 1,450,427 |
| Alabama | 30,843 | 2,441 | 2,099 | 342 | 2,426 | 2,099 | 327 | 30,828 |
| Arizona | 6,919 | 1,087 | 593 | 494 | 828 | 593 | 235 | 6,660 |
| Arkansas | 18,364 | 1,096 | 785 | 311 | 1,584 | 785 | 799 | 18,852 |
| California | 80,256 | 16,234 | 14,434 | 1,800 | 15,062 | 14,434 | 628 | 79,084 |
| Colorado | 13,833 | 1,698 | 1,289 | 409 | 1,594 | 1,289 | 305 | 13,729 |
| Connecticut | 17,892 | 3,058 | 2,706 | 352 | 3,248 | 2,706 | 542 | 18,082 |
| Delaware | 3,290 | 390 | 247 | 143 | 360 | 247 | 113 | 3,260 |
| District of Columbia | 8,727 | 911 | | 911 | 404 | | 404 | 8,220 |
| Florida | 20,960 | 3,132 | 1,667 | 1,465 | 2,115 | 1,667 | 448 | 19,943 |
| Georgia | 34,446 | 1,747 | 1,462 | 285 | 2,021 | 1,462 | 559 | 34,720 |
| Idaho | 4,752 | 678 | 481 | 197 | 778 | 481 | 297 | 4,852 |
| Illinois | 87,739 | 9,728 | 8,408 | 1,320 | 10,373 | 8,408 | 1,965 | 88,384 |
| Indiana | 40,929 | 3,164 | 2,469 | 695 | 3,310 | 2,469 | 841 | 41,075 |
| Iowa | 26,485 | 3,031 | 2,402 | 629 | 3,012 | 2,402 | 610 | 26,466 |
| Kansas | 19,204 | 2,365 | 1,808 | 557 | 2,459 | 1,808 | 651 | 19,298 |
| Kentucky | 30,899 | 2,139 | 1,767 | 372 | 2,440 | 1,767 | 673 | 31,200 |
| Louisiana | 25,010 | 3,590 | 3,292 | 298 | 3,586 | 3,292 | 294 | 25,006 |
| Maine | 11,465 | 1,204 | 986 | 218 | 1,225 | 986 | 239 | 11,486 |
| Maryland | 22,083 | 2,487 | 1,804 | 683 | 2,516 | 1,804 | 712 | 22,112 |
| Massachusetts | 52,248 | 8,417 | 7,466 | 951 | 8,319 | 7,466 | 853 | 52,150 |
| Michigan | 53,472 | 7,462 | 6,781 | 681 | 7,520 | 6,781 | 739 | 53,530 |
| Minnesota | 26,905 | 4,263 | 3,271 | 992 | 3,860 | 3,271 | 589 | 26,502 |
| Mississippi | 23,856 | 432 | 311 | 121 | 778 | 311 | 467 | 24,202 |
| Missouri | 44,974 | 3,854 | 2,855 | 999 | 3,908 | 2,855 | 1,053 | 45,028 |
| Montana | 6,128 | 921 | 774 | 147 | 1,002 | 774 | 228 | 6,209 |
| Nebraska | 13,199 | 1,488 | 1,218 | 270 | 1,661 | 1,218 | 443 | 13,372 |
| Nevada | 1,322 | 311 | 234 | 77 | 330 | 234 | 96 | 1,341 |
| New Hampshire | 6,528 | 846 | 517 | 329 | 849 | 517 | 332 | 6,531 |
| New Jersey | 45,003 | 9,563 | 8,544 | 1,019 | 10,190 | 8,544 | 1,646 | 45,630 |
| New Mexico | 6,422 | 962 | 484 | 478 | 703 | 484 | 219 | 6,163 |
| New York | 153,772 | 20,950 | 18,644 | 2,306 | 20,487 | 18,644 | 1,843 | 153,309 |
| North Carolina | 33,981 | 3,764 | 3,149 | 615 | 3,557 | 3,149 | 408 | 33,774 |
| North Dakota | 5,440 | 1,093 | 893 | 200 | 1,185 | 893 | 292 | 5,532 |
| Ohio | 80,189 | 7,709 | 6,722 | 987 | 7,950 | 6,722 | 1,228 | 80,430 |
| Oklahoma | 21,313 | 2,076 | 1,828 | 248 | 2,558 | 1,828 | 730 | 21,795 |
| Oregon | 12,341 | 1,817 | 1,384 | 433 | 1,649 | 1,384 | 265 | 12,173 |
| Pennsylvania | 114,949 | 12,531 | 11,345 | 1,186 | 13,131 | 11,345 | 1,786 | 115,549 |
| Rhode Island | 8,334 | 1,511 | 1,304 | 207 | 1,537 | 1,304 | 233 | 8,360 |
| South Carolina | 20,540 | 3,270 | 3,044 | 226 | 3,311 | 3,044 | 267 | 20,581 |
| South Dakota | 5,959 | 988 | 796 | 192 | 1,056 | 796 | 260 | 6,027 |
| Tennessee | 30,232 | 2,565 | 1,371 | 1,194 | 1,780 | 1,371 | 409 | 29,447 |
| Texas | 65,448 | 6,564 | 5,716 | 848 | 6,409 | 5,716 | 693 | 65,293 |
| Utah | 4,989 | 788 | 600 | 188 | 723 | 600 | 123 | 4,924 |
| Vermont | 4,981 | 331 | 194 | 137 | 416 | 194 | 222 | 5,066 |
| Virginia | 31,119 | 4,055 | 3,514 | 541 | 4,281 | 3,514 | 767 | 31,345 |
| Washington | 19,094 | 2,785 | 2,393 | 392 | 2,891 | 2,393 | 498 | 19,200 |
| West Virginia | 19,190 | 2,600 | 2,140 | 460 | 2,596 | 2,140 | 456 | 19,186 |
| Wisconsin | 31,973 | 5,532 | 4,983 | 549 | 5,624 | 4,983 | 641 | 32,065 |
| Wyoming | 2,430 | 246 | 90 | 156 | 272 | 90 | 182 | 2,456 |

TABLE 4.—*Number of births, according to place of residence, in the United States, 1937*

| Area | Total births in area | Births— | | | | | | Total births of residents |
|---|---|---|---|---|---|---|---|---|
| | | Of nonresidents in area | | | Of residents in other areas | | | |
| | | Total | From same State | From other States | Total | In same State | In other States | |
| United States | 2,203,337 | 330,000 | 305,763 | 24,237 | 330,000 | 305,763 | 24,237 | 2,203,337 |
| Alabama | 61,611 | 2,622 | 2,507 | 115 | 2,734 | 2,507 | 227 | 61,723 |
| Arizona | 10,494 | 911 | 870 | 41 | 1,055 | 870 | 185 | 10,638 |
| Arkansas | 35,236 | 2,895 | 2,582 | 313 | 3,088 | 2,582 | 506 | 35,429 |
| California | 94,230 | 22,772 | 22,519 | 253 | 22,926 | 22,519 | 407 | 94,384 |
| Colorado | 19,610 | 2,939 | 2,636 | 303 | 2,833 | 2,636 | 197 | 19,504 |
| Connecticut | 22,774 | 6,575 | 6,222 | 353 | 6,769 | 6,222 | 547 | 22,968 |
| Delaware | 4,355 | 816 | 678 | 138 | 815 | 678 | 137 | 4,354 |
| District of Columbia | 12,343 | 2,543 | ------- | 2,543 | 345 | ------- | 345 | 10,145 |
| Florida | 29,507 | 1,180 | 1,113 | 67 | 1,354 | 1,113 | 241 | 29,681 |
| Georgia | 64,061 | 6,269 | 5,828 | 441 | 6,027 | 5,828 | 199 | 63,819 |
| Idaho | 10,369 | 1,628 | 1,348 | 280 | 1,681 | 1,348 | 333 | 10,422 |
| Illinois | 115,282 | 16,358 | 15,732 | 626 | 17,173 | 15,732 | 1,441 | 116,097 |
| Indiana | 56,087 | 6,026 | 5,270 | 756 | 5,764 | 5,270 | 494 | 55,825 |
| Iowa | 42,105 | 6,979 | 6,218 | 761 | 6,743 | 6,218 | 525 | 41,869 |
| Kansas | 29,325 | 4,452 | 3,784 | 668 | 4,361 | 3,784 | 577 | 29,234 |
| Kentucky | 56,163 | 3,701 | 3,335 | 366 | 3,811 | 3,335 | 476 | 56,273 |
| Louisiana | 46,006 | 5,404 | 5,168 | 236 | 5,385 | 5,168 | 217 | 45,987 |
| Maine | 15,246 | 2,106 | 1,980 | 126 | 2,157 | 1,980 | 177 | 15,297 |
| Maryland | 27,739 | 3,198 | 2,642 | 556 | 4,414 | 2,642 | 1,772 | 28,955 |
| Massachusetts | 61,736 | 16,316 | 15,492 | 824 | 15,970 | 15,492 | 478 | 61,390 |
| Michigan | 91,539 | 13,901 | 13,467 | 434 | 13,897 | 13,467 | 430 | 91,535 |
| Minnesota | 48,036 | 7,824 | 7,101 | 723 | 7,761 | 7,101 | 660 | 47,973 |
| Mississippi | 52,095 | 5,235 | 4,919 | 316 | 5,243 | 4,919 | 324 | 52,103 |
| Missouri | 56,951 | 7,174 | 6,070 | 1,104 | 6,740 | 6,070 | 670 | 56,517 |
| Montana | 10,248 | 1,955 | 1,825 | 130 | 2,057 | 1,825 | 232 | 10,350 |
| Nebraska | 22,270 | 2,680 | 2,253 | 427 | 2,609 | 2,253 | 356 | 22,199 |
| Nevada | 1,742 | 387 | 313 | 74 | 443 | 313 | 130 | 1,798 |
| New Hampshire | 7,633 | 1,536 | 1,087 | 449 | 1,383 | 1,087 | 296 | 7,480 |
| New Jersey | 54,607 | 20,332 | 19,878 | 454 | 21,220 | 19,878 | 1,342 | 55,495 |
| New Mexico | 13,837 | 1,138 | 922 | 216 | 1,180 | 922 | 258 | 13,879 |
| New York | 185,502 | 36,533 | 34,945 | 1,588 | 35,965 | 34,945 | 1,020 | 184,934 |
| North Carolina | 79,080 | 6,647 | 6,337 | 310 | 6,713 | 6,337 | 376 | 79,146 |
| North Dakota | 12,637 | 2,866 | 2,387 | 479 | 2,749 | 2,387 | 362 | 12,520 |
| Ohio | 107,576 | 13,699 | 12,670 | 1,029 | 13,428 | 12,670 | 758 | 107,305 |
| Oklahoma | 41,456 | 4,035 | 3,688 | 347 | 4,174 | 3,688 | 486 | 41,595 |
| Oregon | 15,457 | 3,157 | 2,781 | 376 | 3,015 | 2,781 | 234 | 15,315 |
| Pennsylvania | 161,288 | 32,802 | 31,490 | 1,312 | 32,647 | 31,490 | 1,157 | 161,133 |
| Rhode Island | 10,240 | 2,770 | 2,452 | 318 | 2,730 | 2,452 | 278 | 10,200 |
| South Carolina | 40,643 | 3,978 | 3,802 | 176 | 3,998 | 3,802 | 196 | 40,663 |
| South Dakota | 11,908 | 2,345 | 2,009 | 336 | 2,453 | 2,009 | 444 | 12,016 |
| Tennessee | 51,938 | 4,233 | 3,398 | 835 | 3,851 | 3,398 | 453 | 51,556 |
| Texas | 116,057 | 11,020 | 10,455 | 565 | 11,004 | 10,455 | 549 | 116,041 |
| Utah | 12,693 | 1,934 | 1,593 | 341 | 1,665 | 1,593 | 72 | 12,424 |
| Vermont | 6,326 | 987 | 825 | 162 | 1,164 | 825 | 339 | 6,503 |
| Virginia | 51,950 | 5,608 | 5,104 | 504 | 6,463 | 5,104 | 1,359 | 52,805 |
| Washington | 25,036 | 5,963 | 5,616 | 347 | 6,005 | 5,616 | 389 | 25,078 |
| West Virginia | 42,240 | 3,309 | 2,823 | 486 | 3,556 | 2,823 | 733 | 42,487 |
| Wisconsin | 53,543 | 9,846 | 9,330 | 516 | 9,904 | 9,330 | 574 | 53,601 |
| Wyoming | 4,530 | 416 | 299 | 117 | 578 | 299 | 279 | 4,692 |

TABLE 5.—*Number of births, deaths, and deaths under 1 year of age in the United States, 1937, by race*

| Area | Births | | | | Deaths | | | | Infant mortality | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Total | White | Negro | Other races | Total | White | Negro | Other races | Total deaths under 1 year | Rate per 1,000 live births |
| United States | 2,203,337 | 1,928,437 | 262,462 | 12,438 | 1,450,427 | 1,254,787 | 187,594 | 8,046 | 119,931 | 54.4 |
| Alabama | 61,611 | 38,208 | 23,401 | 2 | 30,843 | 16,528 | 14,311 | 4 | 3,844 | 62.4 |
| Arizona | 10,494 | 9,188 | 190 | 1,116 | 6,919 | 5,693 | 248 | 978 | 1,267 | 120.7 |
| Arkansas | 35,236 | 26,615 | 8,611 | 10 | 18,364 | 12,722 | 5,637 | 5 | 1,919 | 54.5 |
| California | 94,230 | 89,745 | 1,565 | 2,920 | 80,256 | 76,645 | 1,675 | 1,936 | 5,070 | 53.8 |
| Colorado | 19,610 | 19,324 | 181 | 105 | 13,833 | 13,547 | 222 | 64 | 1,441 | 73.5 |
| Connecticut | 22,774 | 22,157 | 614 | 3 | 17,892 | 17,439 | 447 | 6 | 921 | 40.4 |
| Delaware | 4,355 | 3,657 | 697 | 1 | 3,210 | 2,686 | 604 | ------- | 278 | 63.8 |
| Dist. of Columbia | 12,343 | 8,274 | 4,044 | 25 | 8,727 | 5,456 | 3,251 | 20 | 751 | 60.8 |
| Florida | 29,507 | 20,564 | 8,927 | 16 | 20,900 | 13,457 | 7,487 | 16 | 1,765 | 59.8 |
| Georgia | 64,061 | 38,194 | 25,857 | 10 | 34,446 | 18,512 | 15,928 | 6 | 3,952 | 61.7 |
| Idaho | 10,369 | 10,282 | 1 | 86 | 4,772 | 4,641 | 12 | 99 | 453 | 43.7 |
| Illinois | 115,282 | 109,422 | 5,785 | 75 | 87,739 | 81,160 | 6,496 | 83 | 4,967 | 43.1 |
| Indiana | 56,087 | 54,264 | 1,823 | ------- | 40,929 | 38,764 | 2,159 | 6 | 2,789 | 49.7 |
| Iowa | 42,105 | 41,801 | 271 | 33 | 26,485 | 26,179 | 291 | 15 | 1,862 | 44.2 |
| Kansas | 29,325 | 28,330 | 945 | 50 | 19,204 | 18,041 | 1,141 | 22 | 1,302 | 44.4 |
| Kentucky | 56,163 | 53,051 | 3,111 | 1 | 30,899 | 26,491 | 4,408 | ------- | 3,321 | 59.1 |
| Louisiana | 46,006 | 26,534 | 19,384 | 88 | 25,010 | 13,465 | 11,524 | 21 | 3,020 | 65.6 |
| Maine | 15,246 | 15,207 | 10 | 29 | 11,465 | 11,414 | 22 | 29 | 996 | 65.3 |
| Maryland | 27,739 | 21,761 | 5,958 | 20 | 22,083 | 17,087 | 4,981 | 15 | 1,705 | 61.5 |
| Massachusetts | 61,736 | 60,782 | 919 | 35 | 52,248 | 51,287 | 891 | 70 | 2,723 | 44.1 |
| Michigan | 91,539 | 88,191 | 3,166 | 182 | 53,472 | 50,486 | 2,841 | 145 | 4,386 | 47.9 |
| Minnesota | 48,036 | 47,426 | 105 | 505 | 26,905 | 26,485 | 166 | 254 | 1,961 | 40.8 |
| Mississippi | 52,095 | 23,248 | 28,763 | 84 | 23,856 | 10,009 | 13,805 | 42 | 3,066 | 58.9 |
| Missouri | 56,951 | 53,418 | 3,516 | 17 | 44,974 | 40,323 | 4,632 | 19 | 3,219 | 56.5 |
| Montana | 10,248 | 9,598 | 14 | 636 | 6,128 | 5,743 | 32 | 353 | 518 | 50.5 |
| Nebraska | 22,270 | 21,979 | 175 | 116 | 13,199 | 12,891 | 228 | 80 | 937 | 42.1 |
| Nevada | 1,742 | 1,572 | 4 | 166 | 1,322 | 1,184 | 7 | 131 | 70 | 40.2 |
| New Hampshire | 7,633 | 7,628 | 3 | 2 | 6,528 | 6,522 | 5 | 1 | 367 | 48.1 |
| New Jersey | 54,607 | 50,346 | 4,239 | 22 | 45,003 | 41,671 | 3,307 | 25 | 2,154 | 39.4 |
| New Mexico | 13,837 | 13,210 | 32 | 595 | 6,422 | 5,948 | 91 | 383 | 1,711 | 123.7 |
| New York | 185,502 | 176,652 | 8,491 | 359 | 153,772 | 145,707 | 7,682 | 383 | 8,369 | 45.1 |
| North Carolina | 79,080 | 53,664 | 24,592 | 824 | 33,981 | 21,237 | 12,549 | 195 | 5,180 | 65.5 |
| North Dakota | 12,637 | 12,165 | 1 | 471 | 5,440 | 5,237 | 2 | 201 | 662 | 52.4 |
| Ohio | 107,576 | 102,023 | 5,523 | 30 | 80,189 | 74,456 | 5,712 | 21 | 5,332 | 49.6 |
| Oklahoma | 41,456 | 37,616 | 2,197 | 1,643 | 21,313 | 18,234 | 2,246 | 833 | 2,345 | 56.6 |
| Oregon | 15,457 | 15,264 | 32 | 161 | 12,341 | 12,126 | 48 | 167 | 642 | 41.5 |
| Pennsylvania | 161,288 | 152,631 | 8,613 | 44 | 114,949 | 107,580 | 7,330 | 39 | 8,109 | 50.3 |
| Rhode Island | 10,240 | 9,954 | 280 | 6 | 8,334 | 8,129 | 197 | 8 | 487 | 47.6 |
| South Carolina | 40,643 | 19,745 | 20,860 | 38 | 20,540 | 9,276 | 11,254 | 10 | 3,074 | 75.6 |
| South Dakota | 11,908 | 11,318 | 6 | 584 | 5,959 | 5,494 | 10 | 455 | 608 | 51.1 |
| Tennessee | 51,938 | 43,859 | 8,074 | 5 | 30,232 | 22,082 | 8,148 | 2 | 3,171 | 61.1 |
| Texas | 116,057 | 102,129 | 13,861 | 67 | 65,448 | 53,301 | 12,117 | 30 | 8,575 | 73.9 |
| Utah | 12,693 | 12,547 | 9 | 137 | 4,989 | 4,876 | 23 | 90 | 526 | 41.4 |
| Vermont | 6,326 | 6,323 | 3 | ------- | 4,981 | 4,973 | 7 | 1 | 313 | 49.5 |
| Virginia | 51,950 | 36,834 | 15,080 | 36 | 31,119 | 19,980 | 11,117 | 22 | 3,619 | 69.7 |
| Washington | 25,036 | 24,370 | 69 | 597 | 19,094 | 18,502 | 152 | 440 | 998 | 39.9 |
| West Virginia | 42,240 | 39,944 | 2,292 | 4 | 19,190 | 17,244 | 1,946 | ------- | 2,610 | 61.8 |
| Wisconsin | 53,543 | 53,007 | 159 | 377 | 31,973 | 31,561 | 178 | 234 | 2,324 | 43.4 |
| Wyoming | 4,530 | 4,416 | 9 | 105 | 2,430 | 2,316 | 27 | 87 | 252 | 55.6 |

TABLE 6.—*Death rates for selected causes in the United States, 1933–37*

| Cause of death [1] | Death rate (number per 100,000 estimated population) | | | | |
|---|---|---|---|---|---|
| | 1937 | 1936 | 1935 | 1934 | 1933 |
| Total deaths | 1,122.1 | 1,151.8 | 1,092.2 | 1,103.2 | 1,067.1 |
| Typhoid and paratyphoid fever (1, 2) | 2.1 | 2.5 | 2.8 | 3.3 | 3.6 |
| Measles (7) | 1.2 | 1.0 | 3.1 | 5.5 | 2.2 |
| Scarlet fever (8) | 1.4 | 1.9 | 2.1 | 2.0 | 2.0 |
| Whooping cough (9) | 3.9 | 2.1 | 3.7 | 5.9 | 3.5 |
| Diphtheria (10) | 2.0 | 2.4 | 3.1 | 3.3 | 3.9 |
| Influenza (11) | 29.4 | 26.3 | 22.1 | 17.3 | 26.4 |
| Dysentery (13) | 2.3 | 2.4 | 1.9 | 2.7 | 2.2 |
| Erysipelas (15) | 1.0 | 1.6 | 1.7 | 1.5 | 1.6 |
| Acute poliomyelitis and acute polioencephalitis (16) | 1.1 | .6 | .8 | .7 | .6 |
| Epidemic cerebrospinal meningitis (18) | 1.7 | 2.4 | 2.1 | 1.0 | 1.2 |
| Tuberculosis of the respiratory system (23) | 49.0 | 50.6 | 49.8 | 51.1 | 53.6 |
| Tuberculosis (all other forms) (24–32) | 4.6 | 5.0 | 5.2 | 5.5 | 5.9 |
| Syphilis (34) | 10.2 | 9.8 | 9.1 | 9.3 | 8.8 |
| Malaria (38) | 2.1 | 3.1 | 3.5 | 3.6 | 3.7 |
| Cancer of digestive tract and peritoneum (46) | 53.6 | 53.1 | 52.1 | 51.7 | 50.2 |
| Cancer of uterus and other female genital organs (48, 49) | 15.5 | 15.4 | 15.1 | 14.9 | 14.4 |
| Cancer of the breast (50) | 10.8 | 10.7 | 10.4 | 10.4 | 9.9 |
| Cancer (all other forms) (45, 47, 51–53) | 32.1 | 31.8 | 30.4 | 29.1 | 27.6 |
| Acute rheumatic fever (56) | 1.5 | 1.7 | 1.8 | 1.8 | 2.0 |
| Chronic rheumatism, osteoarthritis (57) | 1.4 | 1.4 | 1.3 | 1.3 | 1.3 |
| Diabetes mellitus (59) | 23.7 | 23.7 | 22.2 | 22.1 | 21.3 |
| Pellagra (62) | 2.5 | 2.9 | 2.8 | 2.8 | 3.1 |
| Alcoholism (acute or chronic) (75) | 2.6 | 2.9 | 2.6 | 2.9 | 2.6 |
| Progressive locomotor ataxia (tabes dorsalis), general paralysis of insane (80, 83) | 3.9 | 4.2 | 4.3 | 4.7 | 4.5 |
| Cerebral hemorrhage, cerebral embolism and thrombosis (82) | 86.5 | 90.8 | 85.5 | 85.4 | 83.9 |
| Chronic rheumatic heart diseases (90a, 92c, 93e, 95c) | 5.8 | | | | |
| Diseases of coronary arteries and angina pectoris (94) | 54.0 | 265.8 | 244.9 | 239.9 | 227.7 |
| Heart diseases (all other forms) (90b, 91, 92a, b, 93a–d, 95a, b) | 208.3 | | | | |
| Arteriosclerosis (except coronary), idiopathic anomalies of blood pressure (97, 102) | 17.8 | 18.6 | 17.5 | 18.5 | 17.3 |
| Pneumonia (all forms) (107–109) | 85.1 | 93.0 | 81.9 | 79.4 | 69.1 |
| Ulcer of stomach and duodenum (117) | 6.8 | 6.7 | 6.6 | 6.1 | 6.0 |
| Diarrhea and enteritis (under 2 years) (119) | 11.1 | 12.2 | 10.4 | 13.4 | 12.5 |
| Diarrhea and enteritis (2 years and over) (120) | 3.5 | 4.2 | 3.7 | 4.9 | 4.7 |
| Appendicitis (121) | 11.9 | 12.8 | 12.7 | 14.3 | 14.1 |
| Hernia, intestinal obstruction (122) | 10.1 | 10.5 | 10.3 | 10.3 | 10.0 |
| Cirrhosis of the liver (124) | 8.5 | 8.2 | 7.9 | 7.7 | 7.4 |
| Biliary calculi and other diseases of the gall bladder and biliary passages (126, 127) | 6.7 | 6.9 | 6.7 | 7.0 | 6.9 |
| Nephritis (130–132) | 79.6 | 83.2 | 81.2 | 84.2 | 82.9 |
| Puerperal septicemia (140, 142a, 145) | 2.9 | 3.6 | 4.1 | 4.0 | 3.9 |
| Puerperal albuminuria and eclampsia, other toxemias of pregnancy (146, 147) | 2.1 | 2.2 | 2.1 | 2.4 | 2.4 |
| Other puerperal causes (141, 142b–144, 148–150) | 3.3 | 3.7 | 3.6 | 3.8 | 3.9 |
| Congenital malformations (157) | 9.2 | 9.4 | 9.3 | 10.0 | 9.6 |
| Suicide (163–171) | 14.9 | 14.2 | 14.3 | 14.9 | 15.9 |
| Homicide (172–175) | 7.6 | 8.0 | 8.3 | 9.5 | 9.6 |
| Automobile accidents (primary) (210) | 28.8 | 27.8 | 26.8 | 26.8 | 23.3 |
| Other motor vehicle accidents (206, 208, 211) | 1.9 | 1.8 | 1.7 | 1.7 | 1.6 |
| Other accidents (176–195, 201–205, 207, 209, 212–214) | 50.7 | 56.0 | 49.7 | 51.2 | 47.4 |
| All other causes | 145.5 | 152.6 | 149.0 | 153.4 | 150.4 |

[1] Figures in parentheses refer to International List titles.

The number of instances of plural births in the United States in 1937 is shown in table 7. The figures include only those cases in which at least one was a live birth. In 1937 there were born in the United States 24,881 sets of twins, 219 sets of triplets, and 4 sets of quadruplets, as compared with 24,569, 277, and 6, respectively, in 1936. The ratios of these figures for multiple births to the total births approximate the ratios based on the frequently mentioned factor of the ascending power of 80, that is the ratio of twins to total births as 1 in $80^2$, of quadruplets, 1 in $80^3$, and so on. On the basis of this mathematical formula the number of twins in 1937 would have been 27,500, of triplets, 360, and of quadruplets, 4, the last being the actual figure for that year.

TABLE 7.—*Plural births by sex and race in the United States, 1937*

| Sex | Cases [1] of plural births | | | |
|---|---|---|---|---|
| | Total | White | Negro | Other races |
| CASES OF TWINS | | | | |
| Total | 24,881 | 20,972 | 3,790 | 119 |
| 2 males | 8,307 | 7,094 | 1,183 | 30 |
| Both living | 7,665 | 6,622 | 1,017 | 26 |
| 1 living | 642 | 472 | 166 | 4 |
| 2 females | 8,096 | 6,849 | 1,198 | 49 |
| Both living | 7,542 | 6,425 | 1,068 | 49 |
| 1 living | 554 | 424 | 130 | ------ |
| 1 male, 1 female | 8,478 | 7,029 | 1,409 | 40 |
| Both living | 7,897 | 6,622 | 1,235 | 40 |
| 1 living—M | 240 | 169 | 71 | ------ |
| F | 341 | 238 | 103 | ------ |
| CASES OF TRIPLETS | | | | |
| Total | 219 | 180 | 37 | 2 |
| 3 males | 59 | 48 | 11 | ------ |
| All living | 52 | 43 | 9 | ------ |
| 2 living | 6 | 5 | 1 | ------ |
| 1 living | 1 | ------ | 1 | ------ |
| 3 females | 56 | 45 | 11 | ------ |
| All living | 45 | 40 | 5 | ------ |
| 2 living | 8 | 2 | 6 | ------ |
| 1 living | 3 | 3 | ------ | ------ |
| CASES OF TRIPLETS—continued | | | | |
| 2 males, 1 female | 49 | 44 | 4 | 1 |
| All living | 40 | 36 | 4 | ------ |
| 2 living, 2 M | 3 | 3 | ------ | ------ |
| 1 M, 1 F | 2 | 1 | ------ | 1 |
| 1 living, F | 4 | 4 | ------ | ------ |
| 1 male, 2 females | 55 | 43 | 11 | 1 |
| All living | 52 | 42 | 9 | 1 |
| 2 living, 1 M, 1 F | 3 | 1 | 2 | ------ |
| CASES OF QUADRUPLETS | | | | |
| Total | 4 | 1 | 3 | ------ |
| 4 males | 1 | ------ | 1 | ------ |
| All living | 1 | ------ | 1 | ------ |
| 3 males, 1 female | 1 | ------ | 1 | ------ |
| All living | 1 | ------ | 1 | ------ |
| 2 males, 2 females | 1 | 1 | ------ | ------ |
| All living | 1 | 1 | ------ | ------ |
| 1 male, 3 females | 1 | ------ | 1 | ------ |
| 2 living, 1 M, 1 F | 1 | ------ | 1 | ------ |

[1] Includes only those cases in which at least 1 was a live birth.

Births by age of parents are shown in table 8. For 1937 the average age of mothers is stated to be 26.9 years, and of fathers 31.3 years, as compared with 27.0 and 31.5 in 1936.

TABLE 8.—*Births, by age of parents, in the United States, 1937*

| Age | Mother | Father |
|---|---|---|
| Total | 2,203,337 | 2,203,337 |
| 10–14 years | 3,142 | 24 |
| 15–19 years | 285,173 | 33,068 |
| 20–24 years | 692,253 | 426,617 |
| 25–29 years | 583,582 | 615,519 |
| 30–34 years | 362,315 | 467,497 |
| 35–39 years | 201,407 | 304,415 |
| 40–44 years | 65,175 | 168,860 |
| 45–49 years | 6,321 | 77,036 |
| 50–54 years | 181 | 27,564 |
| 55 years and over | 4 | 16,288 |
| Not stated | 3,784 | 66,449 |

TABLE 9.—*Number of deaths under 1 year, from selected causes, by age, in the United States, 1937*

| Cause of death | Total deaths under 1 year | Under 1 day | 1 day | 2 days | 3–6 days | 1 week | 2 weeks | 3 weeks | Under 1 month | 1–12 months |
|---|---|---|---|---|---|---|---|---|---|---|
| All causes | 119,931 | 32,413 | 8,214 | 5,047 | 8,817 | 6,484 | 4,225 | 3,687 | 68,887 | 51,044 |
| Measles (7) | 332 | 1 | ------ | ------ | 1 | 2 | 4 | 6 | 14 | 318 |
| Scarlet fever (8) | 68 | ------ | ------ | ------ | ------ | ------ | 3 | ------ | 3 | 65 |
| Whooping cough (9) | 3,171 | 1 | ------ | 1 | 5 | 10 | 34 | 104 | 155 | 3,016 |
| Diphtheria (10) | 260 | 1 | ------ | 2 | 4 | 4 | 5 | 9 | 25 | 235 |
| Influenza (11) | 3,719 | 12 | 8 | 10 | 67 | 119 | 132 | 145 | 493 | 3,226 |
| Dysentery (13) | 1,074 | 2 | ------ | 2 | 6 | 17 | 12 | 21 | 60 | 1,014 |
| Erysipelas (15) | 270 | ------ | ------ | ------ | 3 | 13 | 28 | 36 | 80 | 190 |
| Encephalitis (lethargic or epidemic) (17) | 22 | ------ | ------ | ------ | ------ | ------ | ------ | ------ | ------ | 22 |
| Meningitis (epidemic cerebrospinal) (18) | 269 | ------ | ------ | ------ | ------ | ------ | 3 | 1 | 4 | 265 |
| Tetanus (22) | 163 | 2 | 1 | 3 | 45 | 88 | 10 | 3 | 152 | 11 |
| Tuberculosis of respiratory system (23) | 287 | 2 | 1 | 1 | 2 | 1 | 3 | 1 | 11 | 276 |
| Tuberculosis of meninges (24) | 209 | ------ | ------ | 1 | 1 | 2 | 1 | 1 | 6 | 203 |
| Other forms of tuberculosis (25–32) | 132 | ------ | ------ | ------ | ------ | 2 | ------ | 3 | 5 | 127 |
| Syphilis (34) | 1,522 | 234 | 72 | 55 | 99 | 79 | 74 | 85 | 698 | 824 |
| Purulent infection, septicemia (36) | 102 | ------ | ------ | 1 | 6 | 11 | 11 | 5 | 34 | 68 |
| Malaria (38) | 226 | 1 | ------ | 5 | 8 | 3 | 4 | 8 | 29 | 197 |
| Other infectious, parasitic diseases (1–6, 12, 14, 16, 19–21, 33, 35, 37, 39–44) | 289 | 2 | 1 | 2 | 2 | 8 | 19 | 18 | 52 | 237 |
| Rickets (63) | 147 | 2 | 1 | ------ | 2 | 3 | 1 | 4 | 13 | 134 |
| Diseases of the thymus gland (67) | 1,140 | 125 | 69 | 75 | 93 | 58 | 45 | 57 | 522 | 618 |
| Hemorrhagic conditions (70) | 246 | 12 | 21 | 29 | 62 | 31 | 19 | 16 | 190 | 56 |
| Anemias (71) | 169 | 6 | 2 | 9 | 12 | 19 | 10 | 3 | 61 | 108 |
| Encephalitis (nonepidemic) (78) | 104 | 3 | 2 | ------ | 3 | 3 | 2 | 1 | 14 | 90 |
| Meningitis (79) | 557 | ------ | ------ | ------ | 11 | 14 | 13 | 16 | 54 | 503 |
| Cerebral hemorrhage, cerebral embolism and thrombosis (82) | 220 | 2 | 3 | ------ | 4 | 4 | 4 | 4 | 21 | 199 |
| Convulsions (86) | 491 | 27 | 18 | 44 | 74 | 46 | 25 | 23 | 257 | 234 |
| Diseases of ear, mastoid process (89) | 576 | 1 | 1 | 1 | 1 | 5 | 3 | 10 | 22 | 554 |
| Other diseases of nervous system and sense organs (80, 81, 83–85, 87, 88) | 185 | 10 | 7 | 4 | 16 | 6 | 5 | 4 | 52 | 133 |
| Diseases of circulatory system (90–103) | 451 | 13 | 5 | 4 | 18 | 33 | 21 | 20 | 114 | 337 |
| Pneumonia, all forms (107–109) | 16,567 | 54 | 135 | 166 | 505 | 701 | 715 | 714 | 2,990 | 13,577 |
| Other diseases of respiratory system (104–106, 110–114) | 1,226 | 24 | 10 | 15 | 55 | 68 | 55 | 55 | 282 | 944 |
| Diseases of buccal cavity and annexa, pharynx, tonsils (115) | 267 | ------ | ------ | ------ | 6 | 17 | 7 | 12 | 42 | 225 |
| Diseases of stomach (117, 118) | 459 | 3 | 5 | 6 | 42 | 33 | 20 | 17 | 126 | 333 |
| Diarrhea and enteritis (119) | 11,672 | 14 | 13 | 27 | 122 | 307 | 462 | 438 | 1,383 | 10,289 |
| Hernia (122a) | 128 | 3 | 1 | 3 | 8 | 2 | 6 | 7 | 30 | 98 |
| Intestinal obstruction (122b) | 825 | 2 | 2 | 6 | 34 | 65 | 23 | 30 | 162 | 663 |
| Peritonitis (cause not specified) (129) | 134 | 1 | 1 | ------ | 6 | 15 | 10 | 14 | 47 | 87 |
| Other diseases of digestive system (116, 121, 123–128) | 206 | 1 | 3 | 4 | 15 | 19 | 12 | 5 | 59 | 147 |
| Diseases of genitourinary system (130, 131, 133–139) | 462 | 8 | 4 | 14 | 34 | 22 | 23 | 31 | 136 | 326 |
| Diseases of skin, cellular tissue (151–153) | 263 | 1 | 1 | 2 | 10 | 50 | 39 | 25 | 128 | 135 |
| Congenital malformations (157) | 10,169 | 2,510 | 791 | 662 | 1,331 | 923 | 497 | 424 | 7,138 | 3,031 |
| Congenital debility (158) | 3,480 | 649 | 226 | 161 | 296 | 231 | 169 | 187 | 1,919 | 1,561 |
| Premature birth (159) | 33,637 | 20,272 | 4,245 | 1,829 | 2,621 | 2,023 | 957 | 577 | 32,524 | 1,113 |
| Injury at birth (160) | 9,598 | 5,145 | 1,419 | 990 | 1,355 | 359 | 150 | 78 | 9,496 | 102 |
| Other diseases of early infancy (161) | 4,792 | 1,842 | 600 | 519 | 955 | 436 | 183 | 90 | 4,625 | 167 |
| External causes (172–195, 201–214) | 2,381 | 147 | 51 | 40 | 107 | 63 | 63 | 72 | 543 | 1,838 |
| Unknown, ill-defined causes (199, 200) | 6,657 | 1,259 | 487 | 343 | 741 | 543 | 330 | 287 | 3,990 | 2,667 |
| All other causes (45–62, 64–66, 68, 69, 72–77, 154–156) | 607 | 19 | 8 | 11 | 29 | 26 | 13 | 20 | 126 | 418 |

Table 9 gives the number of deaths under 1 year of age, by cause, and table 10 shows the number of these deaths by certain subdivision age groups of the first year of life and the percent which deaths in the age groups under 6 months are of the total infant mortality. The percentage of infants dying in each of the groups under 6 months was higher in 1937 than in 1927.

The numbers of births and deaths by months and the monthly percent of the total are presented in table 11. While the births show only a slight seasonal variation, with the highest percentages in July, August, and September, the monthly percentages of deaths present the well-known seasonal pattern, with the lowest rates in the summer and early fall and the highest rates in the winter and early spring, when the respiratory infections and their sequellae contribute to the increased toll of lives.

TABLE 10.—*Number of deaths under 1 year of age, by subdivisions of the first year of life, in the registration area, 1927–37*

| Year | Number | | | | | Percent of total | | | |
|---|---|---|---|---|---|---|---|---|---|
| | Total deaths under 1 year | Under 1 day | Under 1 week | Under 1 month | Under 6 months | Under 1 day | Under 1 week | Under 1 month | Under 6 months |
| 1937: | | | | | | | | | |
| Total | 119,931 | 32,413 | 54,491 | 68,887 | 101,881 | 27.0 | 45.4 | 57.4 | 84.9 |
| White | 97,064 | 27,974 | 46,022 | 57,309 | 83,168 | 28.8 | 47.4 | 59.0 | 85.7 |
| Negro | 21,513 | 4,277 | 8,114 | 11,075 | 17,698 | 19.9 | 37.7 | 51.5 | 82.3 |
| Other | 1,354 | 162 | 355 | 503 | 1,015 | 12.0 | 26.2 | 37.1 | 75.0 |
| 1936 | 122,535 | 32,297 | 55,210 | 69,869 | 103,781 | 26.4 | 45.1 | 57.0 | 84.7 |
| 1935 | 120,138 | 32,237 | 54,877 | 69,834 | 102,252 | 26.8 | 45.7 | 58.1 | 85.1 |
| 1934 | 130,185 | 33,300 | 57,265 | 73,841 | 109,528 | 25.6 | 44.0 | 56.7 | 84.1 |
| 1933 | 120,887 | 31,413 | 54,744 | 70,658 | 102,237 | 26.0 | 45.3 | 58.4 | 84.6 |
| 1932 | 119,431 | 31,050 | 54,082 | 69,496 | 101,457 | 26.0 | 45.3 | 58.2 | 85.0 |
| 1931 | 130,134 | 31,786 | 55,958 | 73,092 | 109,005 | 24.4 | 43.0 | 56.2 | 83.8 |
| 1930 | 142,413 | 33,062 | 59,922 | 78,657 | 118,794 | 23.2 | 42.1 | 55.2 | 83.4 |
| 1929 | 146,661 | 33,258 | 60,869 | 80,063 | 121,572 | 22.7 | 41.5 | 54.6 | 82.9 |
| 1928 | 153,492 | 34,234 | 62,970 | 83,086 | 125,898 | 22.3 | 41.0 | 54.1 | 82.0 |
| 1927 | 138,017 | 32,180 | 58,724 | 77,094 | 115,041 | 23.3 | 42.5 | 55.9 | 83.4 |

TABLE 11.—*Number of births and deaths, by month, in the United States, 1937*

| | January | February | March | April | May | June | July | August | September | October | November | December |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Births: | | | | | | | | | | | | |
| Number | 182,232 | 170,698 | 189,650 | 175,708 | 181,023 | 177,588 | 195,407 | 201,292 | 192,513 | 183,842 | 172,924 | 180,460 |
| Percent | 8.3 | 7.7 | 8.6 | 8.0 | 8.2 | 8.1 | 8.9 | 9.1 | 8.7 | 8.3 | 7.8 | 8.2 |
| Deaths: | | | | | | | | | | | | |
| Number | 148,907 | 137,604 | 137,512 | 124,438 | 119,681 | 108,155 | 112,280 | 105,689 | 102,330 | 114,255 | 112,204 | 126,272 |
| Percent | 10.3 | 9.5 | 9.5 | 8.6 | 8.3 | 7.5 | 7.7 | 7.4 | 7.1 | 7.9 | 7.7 | 8.7 |

An interesting table is included in the Census report showing the number of deaths from motor vehicle accidents by the day of the week on which the accident occurred. The number of deaths due to automobile accidents, which constitutes approximately 94 percent of the total in this group, shows the largest toll of lives taken by this cause over the week-end, as would naturally be expected as a result of in-

TABLE 12.—*Number of deaths from motor vehicle accidents, by day of accident, in the United States, 1937*

| Type of accident | Total | Sunday | Monday | Tuesday | Wednesday | Thursday | Friday | Saturday | Unknown |
|---|---|---|---|---|---|---|---|---|---|
| Total | 39,643 | 7,676 | 4,423 | 3,819 | 3,983 | 4,173 | 5,064 | 7,425 | 3,080 |
| Railroad and automobile (206) | 1,810 | 274 | 212 | 183 | 191 | 228 | 266 | 312 | 144 |
| Street car and automobile (208) | 264 | 73 | 37 | 20 | 28 | 19 | 35 | 36 | 16 |
| Automobile (210) | 37,205 | 7,239 | 4,134 | 3,579 | 3,737 | 3,886 | 4,719 | 7,013 | 2,898 |
| Motorcycle (211) | 364 | 90 | 40 | 37 | 27 | 40 | 44 | 64 | 22 |

TABLE 13.—*Number of deaths from cancer, by site and sex, in the registration area*

| Cause of death | 1937 | | 1935 | | 1930 [1] | | 1925 [1] | | 1920 [1] | |
|---|---|---|---|---|---|---|---|---|---|---|
| | M. | F. | M. | F. | M. | F. | M. | F. | M. | F. |
| Cancers and other malignant tumors (45–53) | 67,349 | 77,425 | 62,933 | 74,716 | 51,777 | 63,488 | 41,865 | 53,639 | 30,933 | 41,998 |
| Cancer of the buccal cavity and pharynx (45) | 4,007 | 974 | 3,982 | 923 | 3,685 | 869 | 3,475 | 759 | 2,335 | 462 |
| Lip | 693 | 78 | 671 | 56 | 540 | 46 | 483 | 70 | 393 | 44 |
| Tongue | 860 | 198 | 878 | 198 | 800 | 147 | 749 | 117 | 609 | 69 |
| Mouth | 441 | 138 | 441 | 109 | 335 | 104 | 285 | 56 | 176 | 61 |
| Jaw | 704 | 216 | 776 | 223 | 811 | 240 | 888 | 223 | 856 | 204 |
| Other and unspecified parts of buccal cavity | 514 | 134 | 466 | 134 | 411 | 109 | 295 | 76 | 211 | 56 |
| Pharynx | 795 | 210 | 750 | 203 | 788 | 223 | 775 | 217 | 90 | 28 |
| Cancer of the digestive tract, peritoneum (46) | 37,307 | 32,028 | 35,224 | 31,237 | 30,431 | 27,381 | 25,375 | 24,080 | 19,058 | 19,285 |
| Esophagus | 2,035 | 546 | 1,715 | 541 | 1,464 | 432 | 1,307 | 352 | 871 | 232 |
| Stomach and duodenum | 16,150 | 10,758 | 16,077 | 11,027 | 14,847 | 10,561 | [2] | [2] | [2] | [2] |
| Intestines (except duodenum, rectum, anus) | 7,175 | 8,803 | 6,428 | 8,037 | 4,826 | 6,170 | [2] | [2] | [2] | [2] |
| Rectum and anus | 4,413 | 3,481 | 3,824 | 3,237 | 2,764 | 2,431 | 2,082 | 1,959 | 1,373 | 1,443 |
| Liver and biliary passages | 4,418 | 5,879 | 4,434 | 6,045 | 4,452 | 5,936 | 4,028 | 5,530 | 3,450 | 5,193 |
| Pancreas | 2,594 | 2,011 | 2,309 | 1,809 | 1,656 | 1,313 | 991 | 911 | 665 | 515 |
| Mesentery and peritoneum | 500 | 533 | 424 | 526 | 398 | 497 | 349 | 471 | 259 | 425 |
| Others under this title | 22 | 17 | 13 | 15 | 24 | 41 | 25 | 45 | 20 | 34 |
| Cancer of the respiratory system (47) | 5,484 | 1,872 | 4,478 | 1,723 | 2,688 | 1,160 | [2] | [2] | [2] | [2] |
| Larynx | 1,083 | 154 | 987 | 165 | 854 | 129 | 636 | 138 | 409 | 90 |
| Lungs and pleura | 3,464 | 1,521 | 2,951 | 1,405 | 1,673 | 980 | 989 | 739 | 527 | 429 |
| Other respiratory organs | 937 | 197 | 540 | 153 | 161 | 51 | [2] | [2] | [2] | [2] |
| Cancer of the uterus (48) | ------- | 16,338 | ------- | 15,853 | ------- | 14,132 | ------- | 12,377 | ------- | 9,848 |
| Cancer of other female genital organs (49) | ------- | 3,643 | ------- | 3,345 | ------- | 2,290 | ------- | 1,674 | ------- | 949 |
| Ovary and Fallopian tube | ------- | 3,018 | ------- | 2,795 | ------- | 1,833 | ------- | 1,218 | ------- | 652 |
| Vagina and vulva | ------- | 577 | ------- | 509 | ------- | 409 | ------- | 398 | ------- | 247 |
| Other female genital organs | ------- | 48 | ------- | 41 | ------- | 48 | ------- | 58 | ------- | 50 |
| Cancer of the breast (50) | 182 | 13,757 | 162 | 13,064 | 138 | 10,774 | 138 | 8,373 | 88 | 6,577 |
| Cancer of the male genitourinary organs (51) | 12,651 | ------- | 11,702 | ------- | 8,661 | ------- | [2] | ------- | [2] | ------- |
| Kidneys and suprarenals (male) | 1,283 | ------- | 1,178 | ------- | 924 | ------- | 717 | ------- | 439 | ------- |
| Bladder (male) | 3,084 | ------- | 3,014 | ------- | 2,512 | ------- | 2,095 | ------- | 1,494 | ------- |
| Prostate | 7,490 | ------- | 6,765 | ------- | 4,648 | ------- | 3,068 | ------- | 1,597 | ------- |
| Testes | 466 | ------- | 412 | ------- | 270 | ------- | 227 | ------- | 143 | ------- |
| Scrotum | 24 | ------- | 34 | ------- | 30 | ------- | 16 | ------- | [2] | ------- |
| Other male genitourinary organs | 304 | ------- | 299 | ------- | 277 | ------- | [2] | ------- | [2] | ------- |
| Cancer of the skin (52) | 2,048 | 1,294 | 2,113 | 1,278 | 1,852 | 1,167 | 1,636 | 988 | 1,505 | 852 |
| Cancer of other or unspecified organs (53) | 5,670 | 7,519 | 5,272 | 7,293 | 4,322 | 5,715 | [2] | [2] | [2] | [2] |
| Kidneys and suprarenals (female) | ------- | 879 | ------- | 870 | ------- | 705 | ------- | 541 | ------- | 381 |
| Bladder (female) | ------- | 1,567 | ------- | 1,485 | ------- | 1,172 | ------- | 913 | ------- | 650 |
| Brain | 802 | 576 | 654 | 487 | 467 | 337 | 223 | 200 | 96 | 88 |
| Bones (except of jaw) | 1,017 | 861 | 889 | 875 | 858 | 753 | 591 | 558 | 343 | 406 |
| Other or unspecified organs | 3,851 | 3,636 | 3,729 | 3,576 | 2,997 | 2,748 | [2] | [2] | [2] | [2] |

[1] The percent of population included in the death registration area for 1920 was 82.3; 1925, 89.6; and 1930, 96.2.

[2] Not comparable.

creased automobile traffic on the highways and probably other factors incident to pleasure seeking. Over 7,000 deaths were recorded as due to automobile accidents on both Saturday and Sunday, as compared with about 4,000 or less for the other days of the week.[1] Friday is the next highest, with nearly 4,719 and Monday next, with 4,134.

Table 13 presents the number of deaths from cancer by principal anatomical site and by sex for 1937 as compared with earlier years. For certain of the earlier years and certain sites the figures are not given, as they are not comparable with those for more recent years, probably because of changes in diagnostic grouping. The cancer death rate was 112.0 per 100,000 population in 1937 as compared with 111.0 in 1936, 107.9 in 1935, and 106.2 in 1934. How much of this increase, as well as that in comparison with rates of still earlier years, may be real or only apparent, because of improved diagnosis, educational work, and greater efforts to discover and treat the disease early, can be determined only by a more detailed analysis of the data. Of course the age distribution and racial composition of the population are important factors in the cancer death rate, and, as has been frequently pointed out, the population is tending to a larger proportion in the older age groups.

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## STUDIES ON IMMUNIZING SUBSTANCES IN PNEUMOCOCCI

### IX. CUTANEOUS TESTS IN NONIMMUNIZED AND IMMUNIZED INDIVIDUALS IN RELATIONSHIP TO SERUM ANTIBODY CONTENT [1]

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In our study of the evaluation of an antigenic polysaccharide of the pneumococcus from the standpoint of prophylaxis in man, there was found an individual variation in the response to a single injection of a constant dose of antigen (*1*). This difference in individual

[1] This is one of a series of studies carried out in part under a grant from the Influenza Commission of the Metropolitan Life Insurance Company.

Preceding papers of this series are as follows:

I. Felton, L. D.: Active immunization of white mice by a nonpolysaccharide and probably nonprotein derivative of the pneumococcus. J. Immunol., 23: 405 (1932).

II. Felton, L. D.: Separation of the organism into acid soluble and acid insoluble fractions. J. Immunol., 27: 379 (1934).

III. Felton, L. D., Kauffmann, G., and Stahl, H. J.: The precipitation of bacterial polysaccharides with calcium phosphate. Pneumococcus. J. Bact., 29: 149 (1935).

IV. Felton, L. D., Sutliff, W. D., and Steele, B. F.: Antigenic characteristics in man of certain products of the pneumococcus. Comparison with vaccine. J. Infect. Dis., 56: 101 (1935).

V. Felton, L. D., and Prescott, B.: The effect of alkalis on the immunizing properties of a type I pneumococcus polysaccharide. Bull. Johns Hopkins Hosp., 59: 114 (1936).

VI Felton, L. D., and Kauffmann, G.: The essential immunizing antigen of types I and II pneumococci. Bull. Johns Hopkins Hosp., 62: 430 (1938).

VII. Felton, L. D.: Response in human beings to antigenic pneumococcus polysaccharides types I and II. Pub. Health Rep., 53: 1855 (1938).

VIII. Ekwurzel, G. M., Simmons, J. S., Dublin, Louis I., and Felton, L. D.: Report on field tests to determine the prophylactic value of a pneumococcus antigen. Pub. Health Rep., 53: 1877 (1938).

response, as measured by serum antibody content, suggests the possibility of using the antigen as a means of dividing the general population into two groups, the good reactors and the poor reactors, or, perhaps, those susceptible and those not susceptible to pneumococcus infections. Such a possibility rests on two assumptions, both of which are subject to experimental proof: First, that among good reactors the morbidity and mortality rates of pneumonia may be low; and second, that among poor reactors these pneumonia rates may be high. In previous studies, the antigenic response has been determined by the serum antibody content estimated from mouse protection tests. This procedure, since it includes drawing blood, separating the serum, and running protection tests which require the use of a large number of mice, is cumbersome and costly. Therefore, inasmuch as evaluation of any prophylactic measure requires the study of a large sample of the general population, the use of the present mouse method is obviously not satisfactory. For this reason, efforts have been made to test the use of the polysaccharide in a skin test as introduced by Francis and Tillett (*2*) as a means of measuring response to specific antigenic stimulation. This preliminary report is an attempt to correlate such a skin test with the presence or absence of serum antibodies in groups of individuals before and after immunization.

The observations of Francis and Tillett (*2*), Finland and Sutliff (*3*), Finland and Dowling (*4*), and others, would indicate that the cutaneous test is positive and largely type-specific in human beings when serum antibodies are present. The work by Francis and Tillett was mostly limited to studies on pneumonia patients. The dose of antigen advocated by them was 0.1 cc. of a 1:10,000 dilution, injected intradermally usually in the inner forearms. The test is considered positive when erythema and wheal occur in from 10 to 30 minutes following the injection, when no reaction results from physiological salt solution given at the same time as a control. A delayed test was observed both by Francis and Tillett and by Finland and Dowling, which was largely nonspecific, and perhaps of little significance. These observations have been confirmed by us.

The Francis and Tillett technique was adopted for this study, except that the dose of specific antigen was varied as indicated. The work was begun with a sample of polysaccharide (SSS) prepared by the revised method of Heidelberger, Kendall, and Scherp (*5*); and for the sake of uniformity this preparation was continued throughout the study. No preservative was used in the skin test antigen. Although it has been found that 0.25 percent phenol apparently does not interfere with the specificity of the reaction, comparative experiments will be necessary before this or any other preservative can be employed. If any is advocated, the control salt solution should contain the same preservative in the same concentration as that in the antigen.

Methods reported elsewhere (*1*) were used both for immunization and for tests for protective antibody. The dose of immunizing antigen, a mixture of type I and type II active polysaccharides, was in most cases 0.4 mg. of each type, or a total of 0.8 mg. Serum antibodies were estimated by injecting 0.1 cc. serum in a series of mice with variation in culture dilutions of 1:1,000 to 1:100,000,000 in logarithmic series. Blood was drawn before injection of either the immunizing or the skin test antigens. Fourteen or more days after immunization blood was drawn again and a second skin test was done. The first sample of serum was kept in the icebox until the second was obtained. Then the sera before and after immunization were tested on the same day. In reading the skin tests account was taken only of the immediate skin reaction appearing in between 10 and 30 minutes.

In comparing results of cutaneous tests with serum antibody titer, obviously there are four possibilities, namely, positive cutaneous reaction with positive or negative serum antibodies, and negative skin reaction with positive or negative serum antibodies. The relationships of interest here are the "skin-positive–blood-positive" and the "skin-negative–blood-negative" ones. Absolute agreement in these would indicate 100 percent correlation between the results of the two tests. Variation from the absolute may be thought of as percent agreement. The total error comprises the number showing positive skin with negative blood and negative skin with positive blood tests.

The individuals tested in this study were all healthy normal persons from Washington County, Maryland, in and around Hagerstown, and from the Byron Tanneries, Williamsport. With the exceptions subsequently noted, none of the individuals tested had had pneumonia for at least one year prior to this experiment.

### EXPERIMENT I. INFLUENCE OF CONCENTRATION OF PNEUMOCOCCUS POLYSACCHARIDE ON INTENSITY OF CUTANEOUS REACTION IN RELATIONSHIP TO SERUM ANTIBODY TITER

Because preliminary tests had indicated that a very small dose of antigen appeared to be more specific than a higher concentration and equally definite in producing the skin reaction, the first experiment was run to ascertain the optimum dose. Sixteen individuals were injected subcutaneously with 2 mg. of type-specific antigens in a 0.5 cc. volume. In table 1 it is seen that, of the 3 individuals immunized with type I, one showed no detectable type I antibodies in 0.1 cc. of the serum, although all 3 had positive skin reactions with the 3 dilutions used.

There were 13 individuals immunized with type II antigen whose sera varied in activity from one in which 0.1 cc. protected mice against 1,000 lethal doses to many which protected against 100,000

lethal doses. It is important to note that the skin tests were all done at one time and that readings, although only roughly quantitative, gave some indication as to the relationship of the intensity of the reaction to the different dilutions of antigen. However, this intensity, indicated by the size of the wheal and the depth of the erythema, showed no relationship to the amount of protective antibody in the serum. For instance, No. 15, an individual whose serum had high protective power, gave a negative skin test with all dilutions of antigen, whereas the 4 individuals who gave the greatest cutaneous response, i. e., No. 8, No. 10, No. 11, and No. 12, had no higher titer of protective antibody than many of the others who gave a less intense reaction.

TABLE 1.—*Influence of concentration of pneumococcus polysaccharide on intensity of cutaneous reaction in relationship to serum antibody titer*

| Number | Age | Type of pneumococcus antigen | Cutaneous reaction after immunization | | | Serum antibodies | |
|---|---|---|---|---|---|---|---|
| | | | SSS dilutions | | | Number of lethal doses against which mice are protected by 0.1 cc. serum | |
| | | | 1:10,000 | 1:100,000 | 1:1,000,000 | Type I | Type II |
| 1 | 49 | I | ++ | + | + | 0 | 10 |
| 2 | 45 | I | ++ | ++ | + | 100,000 | 10 |
| 3 | 31 | I | ++ | ++ | + | 100,000 | 100 |
| 4 | 58 | II | + | + | 0 | 0 | 1,000 |
| 5 | 50 | II | +++ | ++ | + | 0 | 100,000 |
| 6 | 46 | II | ++ | ++ | + | 0 | 100,000 |
| 7 | 45 | II | ++ | ++ | ++ | 0 | 100,000 |
| 8 | 32 | II | ++++ | +++ | +++ | 100 | 10,000 |
| 9 | 39 | II | +++ | ++ | + | 0 | 100,000 |
| 10 | 50 | II | +++ | +++ | +++ | 0 | 10,000 |
| 11 | 45 | II | +++ | +++ | +++ | 0 | 10,000 |
| 12 | 45 | II | +++ | +++ | +++ | 0 | 100,000 |
| 13 | 32 | II | + | 0 | 0 | 0 | 100,000 |
| 14 | 43 | II | ++ | + | + | 0 | 100,000 |
| 15 | 31 | II | 0 | 0 | 0 | 0 | 100,000 |
| 16 | 40 | II | ++ | ++ | + | 0 | 100,000 |

Thus, as shown above in the table, there is no correlation between intensity of reaction to different dilutions and quantity of antibodies. The degree of intensity doubtless depends upon individual characteristics (not related to serum antibodies as measured by the mouse test), such as thickness, texture, and pigment of the skin, and perhaps age of the individual. Furthermore, it would appear that, although the numbers of individuals tested are small, for skin reactions the 1:10,000 dilution of the types I and II polysaccharides as prepared by the recent Heidelberger method is apparently superior to a lower concentration. Consequently, except as noted, this dose has been used throughout.

## EXPERIMENT II. CUTANEOUS REACTIONS IN NON-IMMUNIZED CHILDREN UNDER FIVE YEARS OF AGE

The work of Sutliff (*6*), Davies (*7*), Felton (*1*), Alston and Lowdon (*8*), and others, indicates that infants failed to respond either to the immunizing antigens or to pneumococcus vaccine, at least to a degree measurable by the presence of protective antibody in the serum. In this experiment, a group of normal children under 2 years of age and from 3 to 5 years was tested to determine the percentage giving a positive skin reaction. Tests were run with 3 dilutions of antigen as in the preceding experiment. Of the group of 17 under 2 years, one child responded against both type I and type II antigens in dilution of 1:10,000 only (table 2). This child, aged 7 months, had been in the hospital 3 months prior to the test with bronchopneumonia, the type of which was not determined. Of the 52 in the group from 3 to 5 years, again only one child gave a positive test with each type, one with type I, another with type II antigen, in dilution of 1:10,000. In the total of 69 children, only these 3 gave positive tests. Since one child gave positive tests against both types, the percentage was 2.9 percent for each type. These results are a confirmation of our observation in which a group of 14 children from 3 to 15 years showed no serum antibodies prior to immunization with active polysaccharide, although all children above 2 years injected with an immunizing dose responded well to the polysaccharide antigen.

TABLE 2.—*Cutaneous reactions in nonimmunized children under 5 years of age*

| Age (years) | Number tested | Positive reactions with various dilutions of antigen | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Type I | | | | | | Type II | | | | | |
| | | 1:10,000 | | 1:100,000 | | 1:1,000,000 | | 1:10,000 | | 1:100,000 | | 1:1,000,000 | |
| | | Number | Percent | Number | Percent | Number | Percent | Number | Percent | Number | Percent | Number | Percent |
| Under 2 | 17 | [1] 1 | 5.9 | 0 | 0 | 0 | 0 | [1] 1 | 5.9 | 0 | 0 | 0 | 0 |
| 3 to 5 | 52 | [2] 1 | 1.9 | 0 | 0 | 0 | 0 | [3] 1 | 1.9 | 0 | 0 | 0 | 0 |
| Total | 69 | 2 | 2.9 | 0 | 0 | 0 | 0 | 2 | 2.9 | 0 | 0 | 0 | 0 |

[1] One child reacted to both antigens.
[2] Reacted only to type I antigen.
[3] Reacted only to type II antigen.

Our results on infants are in complete contrast to those of Sutliff and Finland (*6*), who state, "In infants less than 15 months of age, an erythema was invariably produced which obscured any immediate specific erythematous reaction. No wheal formation was observed." Alston and Lowdon (*8*), in testing 15 infants up to 1½ years of age, failed to observe any reactivity in this age group. The difference in results obtained by Sutliff and Finland, and by Alston and Lowdon

and the present writers can undoubtedly be explained on the basis of the use of different preparations of the polysaccharide. Sutliff and Finland used a sample prepared by the original method of Heidelberger and Avery (*9*), which, although antigenic for human beings, had low antigenicity for mice; while in both Alston and Lowdon's work and in our own, the preparation used was made by the revised method of Heidelberger and coworkers, a sample very similar to the one used by us previously which was antigenic for both mice and men (*1*). The difference certainly was due to variation in the antigen and not to the different infants tested. It is pertinent that the preparation used throughout this experiment gave a satisfactory erythematous wheal reaction in adults.

### EXPERIMENT III. RELATIONSHIP BETWEEN INTENSITY OF CUTANEOUS REACTIONS AND SERUM ANTIBODY CONTENT

As the work progressed, it became apparent that the degree of correlation was not high between antibody content of the serum and presence of skin reactions of individuals immunized with polysaccharide. In Tables 3A and 3B are given the results obtained in a group of individuals selected from 179 persons, all of whom were immunized at one time with the same dose of a polyvalent antigen and likewise tested for skin reactions. Antibody titer was estimated in serum drawn before and 14 days after injection of the antigen. Twenty men were chosen at random from those who gave positive

TABLE 3A.—*Relationship between intensity of positive cutaneous reactions and serum antibody content*

| Name | Age | Cutaneous reaction with SSS dilution 1:100,000 | | Serum antibodies | |
|---|---|---|---|---|---|
| | | | | Number of lethal doses against which mice are protected by 0.1 cc. serum | |
| | | Type I | Type II | Type I | Type II |
| C. A. S. | 61 | + | + | 5 | 50,000 |
| J. H. | 54 | ++ | ++ | 5 | 50,000 |
| H. B. | 47 | + | + | 50 | 50,000 |
| C. W. H. | 64 | ++ | ++ | 500 | 50 |
| P. F. C. | 23 | + | + | 500 | 500,000 |
| R. P. T. | 60 | +++ | ++ | 500 | 500 |
| S. B. | 56 | +++ | ++ | 500 | 2,000,000 |
| J. E. Y. | 58 | + | ++ | 5,000 | 500,000 |
| C. H. | 50 | ++ | ++ | 50,000 | 50,000 |
| A. K. | 46 | ++ | ++ | 50,000 | 2,000,000 |
| L. M. | 30 | +++ | + | 50,000 | 500,000 |
| L. S. | 43 | +++ | + | 50,000 | 500,000 |
| G. F. R. | 32 | ++ | ++ | 50,000 | 2,000,000 |
| I. C. S. | 60 | ++ | ++ | 500,000 | 500 |
| G. S. L. | 32 | ++ | ++ | 500,000 | 5,000 |
| G. P. | 32 | + | + | 500,000 | 2,000,000 |
| McK. S. | 41 | ++ | +++ | 500,000 | 50,000 |
| G. Z. | 43 | +++ | ++ | 500,000 | 50,000 |
| R. H. | 65 | ++ | ++ | 500,000 | 50,000 |
| B. F. T. | 55 | +++ | +++ | 2,000,000 | 500,000 |

skin reactions as well as serum antibodies (table 3A). The intensity of the skin reactions varied, as did also the serum antibody titer. However, as shown in the first experiment, with this group intensity of skin reaction did not correlate with titer of serum antibody. A study of the table will be convincing; for example, G. P. gave a positive (+) skin test against both types I and II, and 0.1 cc. serum protected mice against 500,000 lethal doses of type I and 2,000,000 lethal doses of type II. On the other hand, R. P. T. gave a very definite cutaneous reaction (type I, +++; type II, ++) and yet 0.1 cc. serum protected against only 500 lethal doses of either type I or type II pneumococci.

TABLE 3B.—*Relationship between intensity of negative cutaneous reactions and serum antibody content*

| Name | Age | Cutaneous reaction with SSS dilution 1:100,000 | | Serum antibodies: Number of lethal doses against which mice are protected by 0.1 cc. serum | |
|---|---|---|---|---|---|
| | | Type I | Type II | Type I | Type II |
| S. B. | 30 | + | 0 | 0 | 50 |
| H. G. | 44 | 0 | + | 0 | 500 |
| C. R. | 51 | 0 | 0 | 50 | 500 |
| H. R. | 44 | 0 | 0 | 50 | 5,000 |
| F. M. | 46 | 0 | 0 | 50 | 50,000 |
| R. C. | 56 | + | 0 | 500 | 5,000 |
| F. M. | 24 | 0 | 0 | 500 | 500,000 |
| N. M. | 43 | 0 | ++ | 500 | 500 |
| A. G. | 44 | 0 | 0 | 500 | 50,000 |
| M. R. | 49 | ++ | 0 | 500 | 0 |
| F. B. | 60 | + | 0 | 500 | 500 |
| J. S. | 58 | ++ | 0 | 500 | 500 |
| C. M. | 33 | ++ | 0 | 500 | 5,000 |
| R. D. | 48 | + | 0 | 5,000 | 500 |
| W. J. | 34 | ++ | 0 | 5,000 | 5,000 |
| H. C. | 32 | ++ | 0 | 5,000 | 50 |
| R. S. | 45 | 0 | 0 | 50,000 | 50 |
| A. H. | 59 | ++ | 0 | 50,000 | 500,000 |
| S. M. | 27 | 0 | 0 | 500,000 | 500 |
| C. G. | 48 | 0 | 0 | 2,000,000 | 2,000,000 |

Table 3B shows the 20 individuals among the 179 who failed to give a skin reaction to either one or both types. Thus the lack of correlation between skin test and serum antibody titer is shown more clearly in this group. Negative skin tests were found with individuals whose sera contained protective antibodies against as high as 2,000,000 lethal doses of pneumococci of both types. Yet one individual, S. B., gave a positive skin test against type I antigen when his serum failed to protect against one lethal dose of type I organisms. However, it is possible that if a larger dose of serum had been used in the mouse test, some protection would have been found. In the group of 20, this is the only exception; in all the others a positive test indicates some serum antibody. On the other hand, negative skin tests do not prove

that serum antibody is absent. This list includes all the negative ones among the group of 179 tested at one time; in other words, 11 percent of the group gave negative cutaneous tests, and yet all had antibody in their sera in varying amounts.

EXPERIMENT IV. CUTANEOUS REACTIONS WITH POLYSACCHARIDE ANTIGEN IN THE GENERAL POPULATION, NONIMMUNIZED AND IMMUNIZED

Tables 4A and 4B show the findings on the immunized individuals in whom skin tests were performed. Analysis has been made in age groups (decades), although with the realization that insufficient numbers of each group are included to make advisable deductions as to the influence of age. However, certain conclusions may be drawn. It is true that of the 70 children under 9 years of age, only 4.3 percent gave positive tests with type I antigen, whereas in persons between 20 and 59 years of age, over 50 percent were positive. In the entire group of 137 non-immunized persons, 25 percent gave a positive skin test; deducting the children under 10, the percentage of positive tests is 48. These figures are lower than those of Rogers and Wagner (*10*) and Alston and Lowdon (*8*). Whether or not this is the true picture in the nonimmunized population, or whether it varies with geographic location awaits tests on a larger group. Such a study is now in progress.

The numbers of individuals tested after immunization, not necessarily the same individuals, are small, with perhaps the exception of the decade 10 to 19. However, our results would indicate that age does not influence the skin test, at least up to 69 years. The percentage of positive reactions in this entire group of 179 is 84.4 percent, as compared with 48 percent (exclusive of the group under 9 years) among the nonimmunized.

The findings with type II, shown in table 4B, are similar with the exception that before immunization the positive reactions occur in a much smaller percentage of the population, i. e., 7.5 percent of the total of 133, or 11.1 percent exclusive of the age group under 9 years. This percentage is markedly lower than that reported by Alston and Lowdon, who found 63 percent positive to type II in a nonimmunized group. However, after immunization, of the 144 individuals tested by us, 112 or 77.8 percent gave positive cutaneous reactions.

Thus with type I the percentage of nonimmunized persons over 10 years of age giving a positive skin reaction was 48 as compared to 84 percent in the immunized group. With type II, the percentages are, respectively, 11 and 78. In other words, after injection of a polyvalent antigen, skin tests were negative to type I in 16 percent and to type II in 22 percent of the persons tested.

TABLE 4A.—*Cutaneous reactions with polysaccharide antigen in the general population, nonimmunized and immunized*

TYPE I

| Age | Nonimmunized | | | Immunized | | |
|---|---|---|---|---|---|---|
| | Number tested | Positive test | | Number tested | Positive test | |
| | | Number | Percent | | Number | Percent |
| Under 9 | 70 | 3 | 4.3 | | | |
| 10 to 19 | 3 | 1 | 33.3 | 64 | 55 | 85.9 |
| 20 to 29 | 17 | 10 | 58.8 | 24 | 22 | 91.7 |
| 30 to 39 | 12 | 6 | 50.0 | 26 | 24 | 92.3 |
| 40 to 49 | 12 | 6 | 50.0 | 33 | 24 | 72.7 |
| 50 to 59 | 9 | 6 | 66.6 | 15 | 13 | 86.7 |
| 60 to 69 | 12 | 3 | 25.0 | 10 | 10 | 100 |
| 70 to 79 | 2 | 0 | 0 | 6 | 3 | 50 |
| 80 to 89 | | | | 1 | 0 | 0 |
| Total | 137 | 35 | 25.5 | 179 | 151 | 84.4 |
| EXCLUDING GROUP UNDER 9 YEARS | | | | | | |
| 10 to 89 | 67 | 32 | 47.8 | | | |

TABLE 4B.—*Cutaneous reactions with polysaccharide antigen in the general population, nonimmunized and immunized*

TYPE II

| Age | Nonimmunized | | | Immunized | | |
|---|---|---|---|---|---|---|
| | Number tested | Positive test | | Number tested | Positive test | |
| | | Number | Percent | | Number | Percent |
| Under 9 | 70 | 3 | 4.1 | | | |
| 10 to 19 | 3 | 1 | 33.3 | 28 | 24 | 85.7 |
| 20 to 29 | 14 | 0 | 0 | 23 | 21 | 91.3 |
| 30 to 39 | 11 | 1 | 9.1 | 26 | 19 | 73.1 |
| 40 to 49 | 12 | 2 | 16.6 | 34 | 24 | 70.6 |
| 50 to 59 | 9 | 2 | 22.2 | 18 | 14 | 77.8 |
| 60 to 69 | 12 | 1 | 8.3 | 9 | 8 | 88.9 |
| 70 to 79 | 2 | 0 | 0 | 5 | 2 | 40 |
| 80 to 89 | | | | 1 | 0 | 0 |
| Total | 133 | 10 | 7.5 | 144 | 112 | 77.8 |
| EXCLUDING GROUP UNDER 9 YEARS | | | | | | |
| 10 to 89 | 63 | 7 | 11.1 | | | |

In addition, another group of nonimmunized individuals was tested with type III antigen, with the usual 1:10,000 dose. The ages varied from 6 to 65 years, with 50 percent in the 10 to 20 decade. No attempt was made to immunize this group with type III polysaccharide after the skin test. Of the 60 individuals tested, only one gave a positive reaction. This individual, 54 years of age, had type III pneumonia the previous year. The skin tests made with types I and II antigen in this case were also positive, definitely with type I, but only slightly with type II.

## EXPERIMENT V. PERCENTAGE AGREEMENT BETWEEN SERUM ANTIBODIES AND CUTANEOUS REACTIONS WITH POLYSACCHARIDE ANTIGEN

The question of correlation of skin tests with antibody is an important one. Groups of persons (tables 5A and 5B) were chosen representing all those on whom both skin tests using polysaccharide antigen, and antibody titrations, were made. In table 5A, the results on 48 nonimmunized individuals show 58 percent agreement between skin tests and type I antibody titer. This figure includes both skin-positive–blood-positive and skin-negative–blood-negative; for type I there were, respectively, 6 and 22 individuals out of 48 in each of these categories. However, when the percentage of skin-positive and blood-positive only is calculated, there is an agreement of only 12 percent for type I in contrast to 46 percent when both skin and blood tests are negative. In other words, 46 percent of the group comprised individuals of different ages giving a negative skin test with negative antibody, and only 12 percent gave positive tests for both. The errors in correlation in the experiment are noted in the column showing lack of agreement in which 12 individuals, or 25 percent, gave a positive skin test when protective antibodies were absent, and 8, or 16 percent, gave a negative skin test when antibodies were present.

TABLE 5A.—*Percentage agreement between serum antibodies and cutaneous reactions with polysaccharide antigen*

TYPE I

| Age | Nonimmunized | | | | | | | | Immunized | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Number tested | S+ B+ | S− B− | S+ B− | S− B+ | Percent agreement | | | Number tested | S+ B+ | S− B− | S+ B− | S− B+ | Percent agreement | | |
| | | | | | | S+ B+ | S− B− | Total | | | | | | S+ B+ | S− B− | Total |
| 10 to 19 | 0 | ---- | ---- | ---- | ---- | ---- | ---- | ---- | 59 | 44 | 3 | 5 | 7 | 74.6 | 5.1 | 79.7 |
| 20 to 29 | 10 | 1 | 3 | 3 | 3 | 10 | 30 | 40 | 17 | 12 | ---- | 3 | 2 | 70.6 | ---- | 70.6 |
| 30 to 39 | 8 | 1 | 5 | 2 | ---- | 12.5 | 62.5 | 75 | 21 | 19 | ---- | 2 | ---- | 90.5 | ---- | 90.5 |
| 40 to 49 | 9 | ---- | 3 | 3 | 3 | ---- | 33.3 | 33.3 | 26 | 15 | 2 | 2 | 7 | 57.7 | 7.7 | 65.4 |
| 50 to 59 | 8 | 3 | 2 | 2 | 1 | 37.5 | 25 | 62.5 | 12 | 11 | ---- | ---- | 1 | 91.7 | ---- | 91.7 |
| 60 to 69 | 11 | 1 | 7 | 2 | 1 | 9.1 | 63.6 | 72.7 | 7 | 7 | ---- | ---- | ---- | 100 | ---- | 100 |
| 70 to 79 | 2 | ---- | 2 | ---- | ---- | ---- | 100 | 100 | 1 | 1 | ---- | ---- | ---- | 100 | ---- | 100 |
| Total | 48 | 6 | 22 | 12 | 8 | 12.5 | 45.8 | 58.3 | 143 | 109 | 5 | 12 | 17 | 76.2 | 3.5 | 79.8 |

S+=positive skin reaction; S−=negative skin reaction.
B+=antibodies present in blood; B−=antibodies absent in blood.

After immunization, the correlation between these two tests is better; for among 143 individuals the total percentage agreement was 80 percent, of which 109, or 76 percent, were positive in both tests, in other words, almost a reciprocal relationship to the percentage agreement before immunization. The errors are somewhat smaller in the immunized, since only 8.2 percent of skin-positive were without demonstrable antibodies, and only 11.8 percent were skin-negative when antibodies were present.

TABLE 5B.—*Percentage agreement between serum antibodies and cutaneous reactions with polysaccharide antigen*

TYPE II

| Age | Nonimmunized | | | | | | | | Immunized | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Number tested | S+ B+ | S− B− | S+ B− | S− B+ | Percent agreement | | | Number tested | S+ B+ | S− B− | S+ B− | S− B+ | Percent agreement | | |
| | | | | | | S+ B+ | S− B− | Total | | | | | | S+ B+ | S− B− | Total |
| 10 to 19 | 0 | ----- | ----- | ----- | ----- | ----- | ----- | ----- | 27 | 23 | 1 | ----- | 3 | 85.2 | 3.7 | 88.9 |
| 20 to 29 | 10 | ----- | 6 | ----- | 4 | ----- | 60 | 60 | 16 | 12 | 1 | 1 | 2 | 75 | 6.2 | 81.2 |
| 30 to 39 | 7 | ----- | 6 | ----- | 1 | ----- | 85.7 | 85.7 | 21 | 17 | ----- | ----- | 4 | 80.9 | ----- | 80.9 |
| 40 to 49 | 10 | ----- | 4 | 1 | 5 | ----- | 40 | 40 | 30 | 20 | 2 | ----- | 8 | 66.7 | 6.7 | 73.4 |
| 50 to 59 | 8 | 1 | 3 | 1 | 3 | 12.5 | 37.5 | 50 | 14 | 10 | ----- | ----- | 4 | 71.4 | ----- | 71.4 |
| 60 to 69 | 11 | ----- | 7 | 1 | 3 | ----- | 63.6 | 63.6 | 7 | 6 | ----- | ----- | 1 | 85.7 | ----- | 85.7 |
| 70 to 79 | 2 | ----- | 2 | ----- | ----- | ----- | 100 | 100 | 0 | ----- | ----- | ----- | ----- | ----- | ----- | ----- |
| Total | 48 | 1 | 28 | 3 | 16 | 2.1 | 58.3 | 60.4 | 115 | 88 | 4 | 1 | 22 | 76.5 | 3.5 | 80.0 |

S+=positive skin reaction; S−=negative skin reaction.
B+=antibodies present in blood; B−=antibodies absent in blood.

As shown in table 5B, for type II the figures are somewhat different. Before immunization, in the group having both tests positive the percentage agreement is as low as 2.1 percent; however, if to this is added the skin-negative–blood-negative, the total percentage agreement is 60.4 percent. On the other hand, after immunization the total percentage agreement is 80.0 percent, of which 76.5 percent had both tests positive. As in type I, the total error after immunization is about 20 percent.

### EXPERIMENT VI. PERCENTAGE AGREEMENT BETWEEN SERUM ANTIBODIES AND CUTANEOUS REACTIONS OBTAINED WITH ANTIGEN-ANTIBODY COMPLEX

In the foregoing experiment, the results would indicate that agreement between skin test and antibody content was not ideal. Some years ago, a study was made using SSS-antibody complex as an immunizing antigen in rabbits and in mice.[2] The complex was also used in a cutaneous test in these animals to detect the presence of serum antibody. It was found that this neutral complex of antigen and antibody gave negative skin tests in highly immunized rabbits, but in normal rabbits a slight but definite positive reaction occurred. This observation to our knowledge has not been made on human beings. It seemed possible that such a test might give better correlation with demonstrable serum antibodies than the one using only the free or uncombined SSS antigen. Hence a preliminary trial was made. The neutral antibody-polysaccharide complex was prepared as follows: The antibody in rabbit serum of high titer was precipitated with such a concentration of SSS that not all antibody present was

[2] Unpublished data.

entirely thrown down; that is, a slight excess of antibody remained in the supernatant serum. This complex was washed once with physiological saline at 4° C. and then once with water, and was finally diluted with water at room temperature to make a concentration of 1:100,000 SSS, assuming that all the polysaccharide used was precipitated with the antibody. Most of the complex dissolved. It was then filtered, without adding preservative, tested for sterility, and was then ready for cutaneous tests. It is important to note that antigen so prepared, due to dissociation of SSS and antibody, gave a slight precipitate with potent rabbit serum. Both type I and type II antigens were prepared in this manner.

As judged from our experience with rabbits, a positive skin test with this antigen denoted the absence of serum antibodies, whereas a negative skin test gave presumptive evidence that antibodies were present. In other words, the skin reaction would be very similar to that of the Schick test in which a negative reaction means the presence of antitoxin.

A summary of the results obtained in this preliminary study is given in table 6. In the case of type I, of 108 nonimmunized individuals, there was only one who gave both positive cutaneous reaction and positive serum antibodies; 74 were negative in both tests; and 27 had negative skin reactions and positive blood tests. In other words, only 27 out of 108 (25 percent) individuals with positive antibody failed to give a skin reaction. Thus, in this nonimmunized group only 25 percent gave the desired reaction, a negative skin test with serum antibodies present. On the other hand, after immunization of these same individuals, with a few additional persons, 111 out of 117, or 95 percent, gave negative skin tests with positive serum antibodies, while 2 with positive blood tests failed to give negative skin tests.

TABLE 6.—*Percentage agreement between serum antibodies and cutaneous reactions obtained with antigen-antibody complex*

| Type | Age | Nonimmunized | | | | | | Immunized | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Number tested | S+ B+ | S− B− | S+ B− | S− B+ | Percent agreement[1] | Number tested | S+ B+ | S− B− | S+ B− | S− B+ | Percent agreement[1] |
| I | 18 to 72 | 108 | 1 | 74 | 7 | 27 | 25 | 117 | 2 | 4 | 0 | 111 | 94.9 |
| II | 18 to 72 | 110 | 1 | 71 | 6 | 32 | 29 | 117 | 9 | 0 | 0 | 108 | 92.3 |

[1] In this table only, percent agreement indicates skin negative (S−), blood positive (B+). S+=positive skin reaction; S−= skin reaction negative; B+=antibodies present in blood; B−=antibodies absent in blood.

With type II, in the nonimmunized group, 32 out of 110 gave negative skin and positive blood serum reactions, and only 1 failed, giving a positive test in both. The correlation between the two tests was,

therefore, 29 percent. On the other hand, after immunization, 108 out of the 117 gave negative skin tests when serum antibodies were present, and 9 were positive to both these tests. It is pertinent to emphasize that this high degree of correlation between skin test response to complex and serum antibodies occurs only after immunization with the polysaccharide. The lack of agreement in individuals before immunization, that is, those giving both negative skin and negative antibody tests, is greater than when the free SSS antigen is used in the skin test. It would appear that the use of the SSS-antibody complex as antigen in the cutaneous test is significantly superior as an indicator to judge the presence of serum antibody, but only in those immunized by injection of pneumococcus polysaccharide.

These tests were carried out with one preparation of complex antigen in which the concentration based on polysaccharide content was 1:100,000. This concentration was used because from preliminary tests negative reactions occurred in the presence of serum antibodies. If higher concentrations are employed this antigen gives, for the most part, the same skin test as the free SSS antigen of Francis and Tillett. Of necessity therefore an appropriate concentration must be chosen to obtain the desired reaction, a negative skin test in the presence of serum antibody and a positive one in its absence.

## DISCUSSION

In this study our interest is primarily limited to the ability of the individual to respond to an immunizing agent as measured by the skin test, with the possibility in mind of determining individual susceptibility to pneumococcus infection. Some individuals shown to be good reactors to the immunizing agent may be separated from others found to be poor reactors. The former are able to develop a high resistance to pneumococcus infection, and if contracting the disease may have a mild attack with recovery assured; whereas the latter are probably the highly susceptible in whom lobar pneumonia may be a very serious infection.

Evidence bearing upon this assumption may be deduced by the results of the skin reaction in cases of lobar pneumonia. For instance, in the original description of the cutaneous test by Francis and Tillett, it is reported that recovery from type I pneumonia in serum-treated cases was invariably accompanied by the development of positive skin reaction to type I SSS. In contrast, only 50 percent of the non-serum-treated type II and III cases who recovered gave a specific response to the homologous SSS. These authors also stated that "antibodies might be present in the blood of the patient, and the skin test remain negative. When, however, the skin test became positive, recovery invariably ensued." In a later publication, Francis (*11*) showed that all but one of 46 convalescent cases treated with

type I pneumococcus serum gave a positive cutaneous reaction. In 7 fatal cases, the skin reactions were persistently negative, even in the presence of circulating type-specific antibodies. Finland and Sutliff (*3*) in a series of 41 cases not serum-treated reported that 30 recovered, of whom 17 gave a positive homologous skin test. Of 11 fatal cases only one showed a positive homologous reaction. In this patient positive tests were elicited 36 and 12 hours before death, and in both instances cultures showed a large number of type II pneumococci in the blood. The serum from 24 of those who recovered protected mice against 100 lethal doses, while 3 others protected against 10 lethal doses of virulent pneumococci. Among the fatal cases, homologous protection against more than 10 lethal doses was not found and heterologous protection was never demonstrated. More recently, in a series reported by McLeod, Hoagland, and Beeson (*12*), of 13 cases who gave a positive skin reaction prior to serum treatment, all survived. It may, perhaps, be inferred from these 3 small series that for the most part the individual who recovers from pneumonia might be considered a good reactor, as indicated by the skin reaction and by the presence of serum antibodies.

Inasmuch as the pneumococcus is widespread in the general population, positive skin reactions should also occur in normal individuals not actively immunized. The observations on the cutaneous test of Francis and Tillett in normal individuals has been reported by Finland and Sutliff, Alston and Lowdon, and Rogers and Wagner. The first investigators tested only 24 individuals who had no recent history of pneumonia. Four of these (16.7 percent) responded against type I, and 10 (41.7 percent) against type II. Rogers and Wagner, using only type I carbohydrate, found that out of 78 persons tested 56, or 71.8 percent, gave a positive skin reaction. In a larger group, 281 persons, Alston and Lowdon observed skin reactions in 63 percent. They state, "In all groups 281 persons were tested, and 178 (63 percent) gave primary reactions exactly similar to those previously produced in pneumonia convalescents with the type I or type II carbohydrate." If from this number the 15 infants under 1½ years of age are deducted, then of the remaining 266, 178 (67 percent) gave positive reactions. The reports of skin tests on this group were for type II SSS only. From our observations 47 percent of 67 individuals gave positive skin tests with type I, and 11 percent of 63 with type II antigen. Inasmuch as pneumococci are almost universally present, the positive skin reactions might be inferred to occur only in individuals who respond readily to pneumococcus antigen. Such individuals may be classified as good reactors.

However, in the study of the comparison between skin reactions and serum antibodies, the correlation was of low degree. The errors are two: First, a positive skin reaction without serum antibody; and

second, a negative one in the presence of antibody. The total error was found to be 42 percent for type I and 40 percent for type II. On the other hand, after immunization of the group tested with the Francis-Tillett technique, the error in both type I and type II was 20 percent. But when the antigen-antibody complex in dilution of 1:100,000 was used as the skin test antigen in immunized individuals instead of the free SSS, this error was reduced to 5 percent with type I and 8 percent with type II. This reduction of the error in correlation between skin test and serum antibody titer, especially, in the case of the complex antigen after immunization, suggests a means of separating the good from the poor reactors.

The results with the immunizing antigen of pneumococcus used in our investigations indicate that for white mice the active polysaccharide contains practically all of the immunizing activity of the pneumococcus, as a matter of fact, many more immunizing doses as tested in white mice than calculated from the organisms from which it is derived (*13*). Moreover, this antigen stimulates demonstrable antibody production best in mice and man. Failure of response in man to a single injection of the antigen occurs in our series in from 2 to 4 percent. This may be due to an inherent characteristic of the individual or a transitory state of an inability to manufacture antibody. Indeed, proof is lacking as to whether the antigenic polysaccharide is the best immunizing agent for man against pneumococcus infection. This proof can be obtained only by comparing in human beings the effect of the original organisms and the various components isolated therefrom. Nevertheless, in the large proportion of individuals injected up to the present time, one injection of the antigen is as active as multiple injections of pneumococcus vaccine. Unfortunately, a study on whole-cell vaccine has not been made in relationship to individual response as measured by serum antibody content. As a matter of fact, vaccines have generally been used in man without proof of antigenicity even in the experimental animal, in the hope of increasing resistance to pneumococcus infections, truly an illogical and unscientific procedure. However, the issue at present is an attempt to measure individual susceptibility to pneumococcus infection.

This report, as well as previous ones, demonstrates the variability of response in humans to the antigenic polysaccharide of the pneumococcus as measured by serum antibody content. Individual variation in response to pneumococcus infection may also be inferred from the mortality rate in lobar pneumonia. For it has long been recognized, even before typing, that in the United States approximately 75 percent of pneumonia patients survive when nonspecific therapeutic measures are employed. In other words, the disease is self-limiting in 3 out of 4 patients. The question arises whether those who survive have either a possible unexplained natural resistance or a

special mechanism for the development of antibodies more readily than those who succumb to the infection. At least this latter assumption is open to experimental proof. For it is relatively simple to inject a large enough sample of the general population of different age groups, and skin test each 14 days afterwards, to divide the number into 2 groups according to the presence or absence of skin reaction. Without further tests, those injected in the 2 groups could be followed over a period of years, and the morbidity and mortality rate of pneumonia determined. If the assumption is correct that among those in the group who fail to react to the skin test the morbidity and mortality rates are high in comparison with the good reactors, then efforts could be directed toward prophylaxis in this relatively small percentage of the population with more assurance of successful results than in any attempt to immunize the general population. For, if, in a larger sample of the population, the reliability of the SSS-antibody complex is confirmed, only approximately 10 percent or less of the population would be considered susceptible. To obtain these facts, experiments carried out over a period of at least 3 years, or until serum antibodies produced by injection of the immunizing antigen are dissipated, would be necessary.

The above assumption leaves out of consideration nonspecific factors which may influence both morbidity and mortality rates in pneumonia. It is well known, from work on experimental animals, that heredity plays a part in resistance of animals to artificially induced infections. Other factors, such as environmental conditions, including geographical location, habits of life, diet, both organic and inorganic, undoubtedly have a bearing on the resistance of humans to infective agents. For a complete study looking towards the prophylaxis of pneumonia, all these elements must be taken into consideration. However, the present thesis is the possibility of separating the general population into 2 groups, good and poor reactors to a specific immunological agent, and of determining just how much the morbidity and mortality rates of lobar pneumonia vary in these 2 groups. It is an approach from the specific standpoint in contrast to methods of increasing general resistance to all infective agents.

## SUMMARY AND CONCLUSIONS

Certain inferences may be drawn from this report on the correlation between cutaneous reactions and pneumococcus serum antibodies in man:

1. There was no quantitative relationship found between the intensity of the skin reactions of Francis and Tillett and serum antibody titer of individuals before or after immunization with antigenic polysaccharide of the pneumococcus.

2. Using the Francis and Tillett test as indicator, it was found that the group of individuals before immunization gave positive reactions to type I skin test antigen in 48 percent and after immunization in 84 percent of cases; with type II in 11 percent and 78 percent, respectively. As measured by the mouse protection test, only 2 percent failed to show protective antibodies in their sera.

3. The percentage of error, or lack of agreement, found between the results of the Francis and Tillett skin test and serum antibody titer for both type I and type II was 20 percent when lack of agreement included those with negative skin reaction and positive blood tests and those with positive skin and negative blood tests.

4. When the antigen-antibody complex in dilution of 1:100,000 is used as skin test antigen, a negative reaction (in contrast to the free antigen of Francis and Tillett) indicates the presence of serum antibodies. This test used in a group of 117 immunized individuals, gave in the case of type I an error of 5.1 percent and with type II, 7.7 percent. There is less discrepancy between skin test and presence of serum antibody in this group of individuals than found in the test with free SSS antigen.

5. A possibility has been suggested of measuring individual susceptibility of man to pneumococcus infections by first injecting an immunizing dose of the polysaccharide, and 14 days afterwards performing a skin test. An indication of immunity, in the case of the Francis-Tillett technique, is a positive skin reaction consisting of erythema and wheal. Conversely, a positive test for immunity with an appropriate dose of the antibody-antigen complex is a negative skin reaction similar to the Schick test in diphtheria when antitoxin is present. Such a procedure would separate individuals into good and poor reactors in view of determining the morbidity and mortality rates of lobar pneumonia in the two groups, as a guide for further study towards possible prophylaxis against pneumococcus infections with the active polysaccharide.

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## ROCKY MOUNTAIN SPOTTED FEVER

### Protective Value for Guinea Pigs of Vaccine Prepared from Rickettsiae Cultivated in Embryonic Chick Tissues [1]

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A simplified technique whereby the yolk sac of the developing chick embryo may be used for the cultivation of rickettsiae of the Rocky Mountain spotted fever and typhus groups has recently been reported by the writer (*1*). It has since been determined that vaccines prepared from rickettsiae grown in chick embryonic tissues can be successfully used for the active immunization of guinea pigs against Rocky Mountain spotted fever.

#### MATERIALS AND METHODS

The material used for the preparation of vaccine was the pooled embryonic tissues (yolk sac, chorioallantois, and embryo) from passage eggs of a western Montana strain of Rocky Mountain spotted fever (series B of the preceding paper (*1*)). In previous experiments (*1*) it was shown that the yolk sac has a higher limit of infectivity than other tissues of the developing chick. The other tissues, however,

[1] From the Division of Infectious Diseases, National Institute of Health, Rocky Mountain Laboratory, Hamilton, Mont.

contain a fairly large number of rickettsiae, and in this series of tests all the embryonic tissues were used.

Before inoculation the eggs were incubated 5 to 10 days at 39° C. The inoculum, 0.5 cc. of a 10-percent yolk-sac suspension in saline, was injected into the yolk by means of a 1¼-inch, 21-gage needle introduced through the air sac end of the egg. The eggs were then placed in a 35° C. incubator until death of the embryo, which invariably occurred in 3 or 4 days. In a few instances incubation at this temperature was continued for a day longer. In either case the eggs were then transferred to room temperatures for periods of 2 to 12 days before use for vaccine preparation.

*Preparation of vaccine.*—The embryonic tissues were completely removed aseptically from a number of eggs of the same transfer and washed once or twice with sterile saline to remove any yolk or other fluids that might be present. They were then drained free from excess moisture, pooled, weighed, and ground with sterile alundum to a homogeneous suspension. Sterile saline was added to make a 2- or 3-percent suspension. A portion of the suspension was reserved for titration and to the remainder was added phenol to 0.4 and formalin to 0.1 percent concentration. The suspension was then stored at 2° C. and subjected to daily shaking for 6 or 7 days. In 12 or 14 days it was centrifuged at 2,500 to 3,000 revolutions per minute for 20 minutes, except for vaccine 39–2. (See table 1.[2]) The supernatant fluid thus obtained was used as vaccine.

## TITRATION TESTS FOR INFECTIVITY OF EMBRYONIC TISSUE SUSPENSIONS

Titrations were made to determine the infective titer of the various suspensions used and to see whether differences found in immunizing powers might be related to the number of infectious doses in the source material. The titer was determined as follows:

The suspension was centrifuged (2,000 to 2,500 revolutions per minute for 15 minutes) to throw down tissue fragments. The supernatant fluid was pipetted off, tenfold dilutions were prepared with ascitic fluid or with a mixture containing equal volumes of ascitic fluid and Tyrode's solution, and each dilution was tested by injecting guinea pigs intraperitoneally with 1 cc. each. Animals that survived or that failed to show the characteristic scrotal reaction were later tested against infectious guinea pig blood.

*Vaccine tests.*—Guinea pigs received subcutaneously either one 1-cc. dose of vaccine or two 1-cc. doses given 6 or 7 days apart. In one test only a single injection of 0.5 cc. of vaccine was used (experiment 3). Temperatures were taken daily throughout the period of immunization as well as through the period following the test for immunity.

[2] An angle centrifuge was used in all experiments.

Twelve to sixteen days after the last injection of vaccine the animals were tested for immunity by injecting each intraperitoneally with 1 cc. of a pooled mixture of citrated whole blood taken from infected guinea pigs on the third or fourth day of fever. Six normal, control guinea pigs received the same inoculum, except that 10 were used in experiment 3. In addition, decimal dilutions ($10^{-1}$, $10^{-2}$, $10^{-3}$, $10^{-4}$) of the blood were tested in other control guinea pigs so as to determine the approximate number of infectious doses given the vaccinated guinea pigs.

## EXPERIMENTAL DATA

Twelve lots of vaccine were prepared and tested. Two lots (39–1 and 39–2) were tested three times, three twice (41, 43, and 44), and the remaining seven, once.

Table 1 presents the data pertaining to the preparation of the various lots.

TABLE 1.—*Preparation data for lots of spotted fever vaccines made from the embryonic tissues of developing chicks. The lot number represents the number of the serial passage of the spotted fever strain in eggs at the time the vaccine was prepared*

| Vaccine No. | Date of preparation | Number of embryos and age when inoculated | Number of days eggs were kept at 35° C. and room temperature before being used | | Concentration of tissue in crude vaccine suspension | Approximate infectivity end-point of tissues |
|---|---|---|---|---|---|---|
| | | | At 35° C. | At room temperature | | |
| | *1938* | | | | | |
| 39–1 | Oct. 8 | 8–5 days | 4 | 3 | [2]$3\times10^{-2}$ | $3\times10^{-3}$ |
| 39–2 [1] | do | | | | $3\times10^{-2}$ | |
| 41 | Oct. 25 | 1–5 day; 1–6 day; 1–7 day; 1–8 day | 4 | 12 | $3\times10^{-2}$ | $3\times10^{-4}$ |
| 43 | Oct. 26 | 4–6 days | 4 | 4 | $3\times10^{-2}$ | $3\times10^{-4}$ |
| 44 | Nov. 4 | do | 4 | 8 | $3\times10^{-2}$ | $3\times10^{-4}$ |
| 52 | Dec. 10 | do | 3 | 4 | $3\times10^{-2}$ | $3\times10^{-7}$ |
| 54 | Dec. 13 | do | 4 | 4 | $2\times10^{-2}$ | $2\times10^{-4}$ |
| 55 | Dec. 15 | 4–7 days | 4 | 2 | $2\times10^{-2}$ | $2\times10^{-4}$ |
| 56–1 | Dec. 20 | 4–6 days | 3 | 3 | $2\times10^{-2}$ | $2\times10^{-4}$ |
| 56–2 | do | 2–7 days | 3 | 3 | $2\times10^{-2}$ | $2\times10^{-4}$ |
| 56–3 | do | 2–8 days | 3 | 3 | $2\times10^{-2}$ | $2\times10^{-4}$ |
| 56–4 | do | 2–10 days | 3 | 3 | $2\times10^{-2}$ | $2\times10^{-4}$ |

[1] Vaccine lot 39–2 was prepared by centrifuging 180 cc. of lot 39–1 at 5,500 revolutions per minute for 1 hour. The precipitate thus obtained, resuspended in 1/10 the original volume (18 cc. of saline containing 0.1 percent formalin and 0.4 percent phenol) constituted lot 39–2.

[2] $3\times10^{-2}$=3 percent; $2\times10^{-2}$=2 percent.

These data show that the infectivity end-point per gram of embryonic tissues varied considerably. Vaccines 41, 54, and 56–3 showed the lowest number of infectious doses (3,000 to 5,000) while vaccine 52, containing at least 3 million infectious doses, showed the highest number. The small number of vaccine lots tested shows no apparent correlation between the infective titer and the length of time the eggs were allowed to stand at incubator and room temperatures.

*Experiment 1.*—The first test was made with vaccine lots 39–1 and 39–2. On October 20, 1938 (12 days after preparation), six guinea pigs received 1 cc. each of lot 39–1 and six others 1 cc. each of lot 39–2. All remained afebrile. The test for immunity was given 12 days later. Ten of the twelve vaccinated animals showed no temperature rise, while two (one for each lot of vaccine) had low fevers for 3 or 4 days, respectively. No scrotal swelling or other evidence of spotted fever was observed in the vaccinated animals. The six controls injected with the undiluted infectious blood as well as those receiving the $10^{-1}$ and $10^{-2}$ dilutions developed typical spotted fever; six died. The controls receiving the $10^{-3}$ and $10^{-4}$ dilutions of blood failed to react and were later shown to be nonimmune.

No differences were detected in the protective properties of the two vaccines, although lot 39–2 was prepared by concentrating lot 39–1 tenfold.

TABLE 2.—*Daily temperature records (°C.) of vaccinated guinea pigs used in experiment 1, vaccine lots 39–1 and 39–2*

Oct. 20, 1938 [1].—Guinea pigs were each injected subcutaneously with 1 cc. of vaccine.
Nov. 1, 1938.—Guinea pigs were each injected intraperitoneally with 1 cc. of infectious blood.

| | Lot 39–1 | | | | | | Lot 39–2 | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Guinea pig No. | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 |
| Nov. 2, 1938 | 39.3 | 39.0 | 39.0 | 39.0 | 38.5 | 39.0 | 38.5 | 39.2 | 39.0 | 39.0 | 39.0 | 38.6 |
| Nov. 3, 1938 | 39.0 | 38.5 | 39.2 | 39.0 | 38.5 | 39.0 | 38.0 | 38.8 | 39.0 | 38.7 | 39.0 | 38.8 |
| Nov. 4, 1938 | 39.0 | 38.7 | 38.5 | 39.2 | 38.8 | 38.8 | 39.2 | 39.0 | 39.0 | 38.9 | 39.3 | 38.7 |
| Nov. 5, 1938 | 39.0 | 38.3 | 39.4 | 38.4 | 39.4 | 39.0 | 39.4 | 39.0 | 39.2 | 38.8 | 39.0 | 39.0 |
| Nov. 6, 1938 | 39.2 | 39.0 | 39.3 | 38.6 | 39.0 | 39.8 | 39.4 | 39.6 | 39.8 | 39.0 | 38.8 | 39.0 |
| Nov. 7, 1938 | 39.4 | 39.4 | 39.0 | 38.8 | 38.5 | 40.0 | 38.7 | 39.0 | 39.8 | 38.8 | 38.9 | 39.0 |
| Nov. 8, 1938 | 39.0 | 39.0 | 39.5 | 39.0 | 38.8 | 40.3 | 38.8 | 39.1 | 39.4 | 38.6 | 38.4 | 38.8 |
| Nov. 9, 1938 | 39.4 | 38.6 | 39.0 | 39.0 | 38.7 | 39.7 | 39.3 | 39.2 | 39.5 | 38.8 | 38.8 | 39.0 |
| Nov. 10, 1938 | 39.4 | 38.6 | 39.1 | 38.8 | 38.8 | 39.0 | 39.1 | 38.8 | 39.5 | 38.8 | 39.0 | 38.8 |
| Nov. 11, 1938 | 39.2 | 39.1 | 39.2 | 39.0 | 39.0 | 39.2 | 39.0 | 38.6 | 39.5 | 38.6 | 38.8 | 38.5 |
| Nov. 12, 1938 | 38.8 | 39.4 | 39.2 | 39.0 | 39.0 | 39.4 | 39.2 | 38.8 | 39.0 | 38.8 | 39.0 | 38.5 |
| Nov. 13, 1938 | 39.2 | 39.0 | 38.6 | 39.0 | 38.5 | 39.2 | 39.3 | 39.2 | 39.4 | 38.5 | 38.5 | 38.8 |
| Nov. 14, 1938 | 39.4 | 39.2 | 38.8 | 39.3 | 38.5 | 38.8 | 39.4 | 39.4 | 39.0 | 38.8 | 39.2 | 38.8 |
| Nov. 15, 1938 | 39.4 | 39.1 | 38.8 | 39.4 | 38.8 | 39.1 | 39.0 | 39.0 | 39.0 | 39.0 | 38.6 | 38.8 |
| Nov. 16, 1938 | 39.4 | 39.0 | 39.1 | 39.0 | 39.0 | 39.4 | 39.2 | 38.8 | 38.8 | 38.8 | 38.6 | 38.6 |

[1] None of the vaccinated guinea pigs showed any thermal reaction due to the injection of vaccine.

Tables 2 and 2a show the temperature records of the vaccinated and control guinea pigs.

*Experiment 2.*—The second test was made with the two vaccine lots used in experiment 1 plus three additional lots (41, 43, and 44). Six animals were used for each lot, and on November 30, 1938, each received 1 cc. of vaccine. The immunity test was given 16 days later.

Of the six animals vaccinated with lot 39–1, none showed scrotal swelling, but one had temperatures of 40.3°, 39.7°, and 39.7° C. on the seventh, eighth, and ninth days, respectively.

Five of the guinea pigs that received lot 39–2 showed no reaction. The sixth died of pneumonia on the second day after being tested for immunity.

TABLE 2a.—*Daily temperature records (°C.) of control guinea pigs used in experiment 1*

November 1, 1938.—Guinea pigs were injected intraperitoneally with 1 cc. each of infectious blood.

| | Undiluted blood | | | | | | Blood dilution | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | $10^{-1}$ | | $10^{-2}$ | | $10^{-3}$ | | $10^{-4}$ | |
| Guinea pig No. | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 |
| Nov. 2, 1938 | 39.0 | 38.6 | 38.8 | 39.0 | 38.8 | 39.0 | 38.4 | 38.5 | 38.8 | 38.8 | 38.7 | 39.0 | 39.2 | 39.0 |
| Nov. 3, 1938 | 39.0 | 39.0 | 38.8 | 39.2 | 39.0 | 39.4 | 39.0 | 39.0 | 39.0 | 39.2 | 38.8 | 38.8 | 38.8 | 38.8 |
| Nov. 4, 1938 | 39.4 | 39.2 | 39.0 | 38.4 | 39.4 | 39.0 | 39.0 | 39.4 | 39.0 | 39.2 | 39.0 | 39.0 | 39.1 | 38.8 |
| Nov. 5, 1938 | 40.2 | 39.8 | 40.4 | 40.0 | 40.6 | 39.2 | 39.0 | 39.0 | 39.0 | 39.4 | 39.2 | 39.0 | 38.8 | 39.0 |
| Nov. 6, 1938 | 40.2 | 40.4 | 40.0 | 40.2 | 40.7 | 40.4 | 40.3 | 39.5 | 39.5 | 39.6 | 39.2 | 39.2 | 39.0 | 39.2 |
| Nov. 7, 1938 | 41.0 SS | 40.7 SS | 40.6 SS | 40.6 | 40.8 SS | 40.2 | 39.8 | 41.0 | 40.0 | 40.4 | 39.2 | 39.2 | 39.0 | 39.0 |
| Nov. 8, 1938 | 40.8 SS | 40.4 SS | 41.0 SS | 40.4 SS | 40.2 SS | 41.0 SS | 39.8 | 41.0 | 39.9 | 40.8 | 39.0 | 39.0 | 39.0 | 38.8 |
| Nov. 9, 1938 | 40.8 SH | 40.8 SH | 41.0 SH | 40.8 SS | 39.2 SS | 40.8 SS | 40.3 SS | 41.3 SS | 40.3 | 40.4 | 39.4 | 38.6 | 39.2 | 39.0 |
| Nov. 10, 1938 | 40.7 SH | 40.8 SH | 41.0 SN | 40.4 SS | 37.0 | 40.6 SH | 40.5 SS | 41.5 SS | 40.4 SS | 40.6 SS | 38.6 | 38.8 | 39.4 | 39.0 |
| Nov. 11, 1938 | 40.0 SN | 40.6 SH | 37.0 SN | 40.0 SS | D | 40.2 SH | 40.0 SS | 40.8 SH | 40.5 SS | 40.0 SS | 38.8 | 39.0 | 38.8 | 39.0 |
| Nov. 12, 1938 | 39.0 SN | 37.2 SN | D | 40.0 SS | ------ | 38.2 SH | 40.3 SS | 40.8 SH | 40.5 SS | 40.0 | 38.0 | 39.2 | 38.8 | 38.8 |
| Nov. 13, 1938 | 37.0 SN | D | ------ | 39.6 SS | ------ | D | 39.4 | 40.6 SN | 40.2 SS | 39.8 | 38.6 | 39.0 | 38.6 | 39.0 |
| Nov. 14, 1938 | D | ------ | ------ | 39.4 | ------ | ------ | 39.2 | 40.4 SN | 40.4 SS | 39.6 | 39.0 | 39.4 | 38.4 | 39.2 |
| Nov. 15, 1938 | ------ | ------ | ------ | 39.2 | ------ | ------ | 39.0 | 39.0 SN | 40.2 SS | 39.2 | 39.2 | 39.2 | 38.6 | 39.0 |
| Nov. 16, 1938 | ------ | ------ | ------ | 39.0 S | ------ | ------ | 39.0 S | D | 39.8 SS S | 39.2 S | 39.0 S | 39.0 S | 38.8 S | 39.0 S |

SS—scrotal swelling.
SH—scrotal hemorrhage.
SN—scrotal necrosis and slough.
S—survived.
D—died.

Of the six that received lot 43, five remained afebrile. The sixth showed a temperature of 40° C. on the eighth and ninth days, but no scrotal reaction.

The six control animals injected with the undiluted blood, as well as the six that received the $10^{-1}$, $10^{-2}$, and $10^{-3}$ dilutions, all developed typical spotted fever. Seven died. Those receiving the $10^{-4}$ dilution remained afebrile.

The results obtained with vaccines 41 and 44 were not significant. Nine of the twelve records were invalidated by concurrent pneumonia. The three remaining guinea pigs (one of lot 41 and two of lot 44) remained afebrile following both the vaccine injection and the immunity test.

*Experiment 3.*—The third test was carried out with the five vaccine lots used in experiment 2 plus seven additional lots (52, 54, 55, 56–1, 56–2, 56–3, and 56–4). The immunization procedure varied somewhat from that used previously. The guinea pigs injected with lot 39–2 received only 0.5 cc. (January 4, 1939), and two series of test

animals were used for each of lots 41, 43, 44, 52, 54, 55, 56–1, 56–2, 56–3, and 56–4. One series received a single injection of 1 cc. (January 4, 1939), while the second received two 1-cc. injections 6 days apart (January 4 and 10). The immunity test was given all animals on January 24. In this experiment 10 control animals received the 1-cc. injections of undiluted infectious blood. The data are summarized in table 3.

TABLE 3.—*Test of vaccinated guinea pigs for protection against Rocky Mountain spotted fever*

| Immunization | | | Test for immunity | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Vaccine Lot No. | Age of vaccine (days) | Dosage | Dilution of blood | Number showing fever of 39.8° C. or above | | | Number showing scrotal swelling | Number fully protected | Number showing typical spotted fever | Number dying of spotted fever |
| | | | | 1 day | 2 days | More than 2 days | | | | |
| 39–1 | 94 | 1 cc. | Undiluted | 0 of 6 | 0 of 6 | 0 of 6 | 0 | 6 of 6 | 0 | 0 |
| 39–2 | 94 | 0.5 cc. | do | 0 of 6 | 0 of 6 | 0 of 6 | 0 | 6 of 6 | 0 | 0 |
| 41 | 77 | 1 cc. | do | 0 of 6 | 0 of 6 | 0 of 6 | 0 | 6 of 6 | 0 | 0 |
| | 71 | 1 cc. twice | do | 0 of 6 | 0 of 6 | 0 of 6 | 0 | 6 of 6 | 0 | 0 |
| 43 | 76 | 1 cc. | do | 0 of 6 | 0 of 6 | 0 of 6 | 0 | 6 of 6 | 0 | 0 |
| | 70 | 1 cc. twice | do | 0 of 6 | 0 of 6 | 0 of 6 | 0 | 6 of 6 | 0 | 0 |
| 44 | 67 | 1 cc. | do | 1 of 4[1] | 0 of 4 | 0 of 4 | 0 | 3 of 4 | 0 | 0 |
| | 61 | 1 cc. twice | do | 1 of 6 | 0 of 6 | 0 of 6 | 0 | 5 of 6 | 0 | 0 |
| 52 | 31 | 1 cc. | do | 0 of 6 | 0 of 6 | 0 of 6 | 0 | 6 of 6 | 0 | 0 |
| | 25 | 1 cc. twice | do | 0 of 6 | 0 of 6 | 0 of 6 | 0 | 6 of 6 | 0 | 0 |
| 54 | 28 | 1 cc. | do | 1 of 6 | 1 of 6 | 0 of 6 | 0 | 4 of 6 | 0 | 0 |
| | 22 | 1 cc. twice | do | 1 of 5[1] | 0 of 5 | 0 of 5 | 0 | 4 of 5 | 0 | 0 |
| 55 | 26 | 1 cc. | do | 0 of 6 | 0 of 6 | 0 of 6 | 0 | 6 of 6 | 0 | 0 |
| | 20 | 1 cc. twice | do | 0 of 6 | 0 of 6 | 0 of 6 | 0 | 6 of 6 | 0 | 0 |
| 56–1 | 21 | 1 cc. | do | 0 of 6 | 0 of 6 | 0 of 6 | 0 | 6 of 6 | 0 | 0 |
| | 15 | 1 cc. twice | do | 1 of 6 | 0 of 6 | 0 of 6 | 0 | 5 of 6 | 0 | 0 |
| 56–2 | 21 | 1 cc. | do | 0 of 6 | 0 of 6 | 0 of 6 | 0 | 6 of 6 | 0 | 0 |
| | 15 | 1 cc. twice | do | 0 of 6 | 0 of 6 | 0 of 6 | 0 | 6 of 6 | 0 | 0 |
| 56–3 | 21 | 1 cc. | do | 2 of 6 | 0 of 6 | 0 of 6 | 0 | 4 of 6 | 0 | 0 |
| | 15 | 1 cc. twice | do | 1 of 6 | 0 of 6 | 0 of 6 | 0 | 5 of 6 | 0 | 0 |
| 56–4 | 21 | 1 cc. | do | 0 of 6 | 0 of 6 | 0 of 6 | 0 | 6 of 6 | 0 | 0 |
| | 15 | 1 cc. twice | do | 1 of 6 | 0 of 6 | 0 of 6 | 0 | 5 of 6 | 0 | 0 |
| Controls | | | Undiluted | ------ | ------ | 10 of 10 | 10 of 10 | ------ | 10 of 10 | 7 of 10 |
| | | | $10^{-1}$ | ------ | ------ | 2 of 2 | 2 of 2 | ------ | 2 of 2 | 1 of 2 |
| | | | $10^{-2}$ | ------ | ------ | 1 of 2 | 1 of 2 | ------ | 1 of 2 | 0 of 2 |
| | | | $10^{-3}$ | ------ | ------ | 0 of 2 | 0 of 2 | ------ | 0 of 2 | 0 of 2 |
| | | | $10^{-4}$ | ------ | ------ | 0 of 2 | 0 of 2 | ------ | 0 of 2 | 0 of 2 |

[1] 2 animals of the lot 44 series and 1 animal of the lot 54 series died of intercurrent infection before being given the immunity test.

The table shows that all 12 vaccines were potent and complete protection was apparently afforded to 119 of the 129 vaccinated guinea pigs (valueless animals excluded). Of the 10 animals that had 1 or 2 days of low fever, none showed scrotal swelling or noticeable evidence of illness. Two of the vaccines, 39–1 and 39–2, had been stored in the cold for 94 days. There was no apparent loss of potency. Moreover, a single injection of 0.5 cc. of vaccine 39–2 afforded complete protection.

It is of interest that infected eggs held at room temperature for as long as 12 days (see lot 41, table 1) yielded potent vaccine.

## DISCUSSION

It has been conclusively established by a number of investigators that active immunity against rickettsial infections can be induced by vaccination with killed rickettsiae. In the case of Rocky Mountain spotted fever, the vaccine of Spencer and Parker (*2*), produced from infected ticks (*Dermacentor andersoni*) has unquestionably been of great value. However, the method of preparation is exceedingly tedious and workers are necessarily exposed in an unusual degree to an ever-present danger of infection.

In 1937 Bengtson (*3*) reported successful immunization of guinea pigs against spotted fever with formolized rickettsial suspensions prepared from infected guinea pig tissues cultivated by a modified Maitland method. By this method the amount of vaccine obtained from the tissues of one guinea pig was sufficient to immunize 40 or 50 guinea pigs against the usual test dose.

In unpublished experiments the writer also has successfully used modified Maitland cultures in carrying 6 series of Rocky Mountain spotted fever cultures through more than 30 serial transplants each. The cultures were prepared by suspending minced chick-embryo tissue in filtered human ascitic fluid.[3] Moderately good growths of rickettsiae were obtained under these conditions, but attempts to increase the yield by substituting *chorio-allantoic membrane* of chick embryos and guinea pig tunicae for the minced chick embryo and by using various modifications of Baker's solution (*4*) (horse, cow, guinea pig, rabbit, and chicken sera, as well as human amniotic and ascitic fluids and filtered extracts of normal tick tissues (*Dermacentor andersoni*)) were not particularly successful. While several potent lots of vaccine were made from the various modified Maitland cultures, none of the cultural variations seemed satisfactory for the preparation of vaccine of consistent potency. Moreover, as Zinsser and his colleagues have recently pointed out (*5*), the Maitland method, because of certain technical difficulties, does not appear to be readily applicable to large-scale production.

The method described in this paper has thus far produced consistently good vaccines. Furthermore, from the standpoints of potential cost, ease of manipulation, and quantity production, it has given results that we have been unable to approach by any other method. Thus, 320 cc. of vaccine 56–2 was prepared from two embryos 7 days

[3] In a similar manner Greek and Moroccan strains of boutonneuse fever were each carried through 20 passages, a strain of exanthematic typhus of Sao Paulo (Brazilian spotted fever) through 15, 2 strains of endemic typhus through 16 and 26, respectively, and a strain of European (epidemic) typhus through 14. However, attempts to grow these rickettsiae in cultures consisting of minced chick-embryo tissue suspended in Tyrode's solution (0.5 gram $NaHCO_3$ per liter) either ended in failure or gave very scanty growth. Somewhat better results were obtained when sera (20 to 40 percent) were added to Tyrode's and the results were still better when various modifications of Baker's solution were used. However, the results were best and most consistent when the suspension medium was filtered human ascitic fluid.

old at the time of inoculation. Even more striking is the fact that 1,080 cc. of vaccine 56–4 was made from two 10-day-old embryos. A single 1 cc. injection of either vaccine was sufficient to protect a guinea pig against the usual test dose of infectious blood. On the basis of the dosage of tick-tissue vaccine now used for human prophylaxis (two injections of 2 cc. each) the amount of vaccine obtained from the two 10-day-old embryos would be sufficient to immunize 270 persons.

### CONCLUSION

Vaccine which will protect guinea pigs against Rocky Mountain spotted fever can be prepared from infected embryonic tissues of developing chicks.

### REFERENCES

(1) Cox, H. R.: Use of yolk sac of developing chick embryo as medium for growing rickettsiae of Rocky Mountain spotted fever and typhus groups. Pub. Health Rep., **53:** 2241 (1938).
(2) Spencer, R. R. and Parker R. R.: Studies on Rocky Mountain spotted fever. Hyg. Lab. Bull. No. 154, 1930. Page 63.
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(4) Baker, Lillian E.: Artificial media for the cultivation of fibroblasts, epithelial cells and monocytes. Science, **83:** 605 (1936).
(5) Zinsser, H., Fitzpatrick, F., and Wei, H.: A study of rickettsiae grown on agar-tissue cultures. J. Exp. Med., **69:** 179 (1939).

## THE PRESERVATION OF LYMPHOCYTIC CHORIOMENINGITIS AND ST. LOUIS ENCEPHALITIS VIRUSES BY FREEZING AND DRYING *IN VACUO* [1]

By JERALD G. WOOLEY, *Bacteriologist, United States Public Health Service*

The maintenance of the viruses of lymphocytic choriomeningitis and encephalitis, St. Louis type, is usually accomplished by serial inoculations of animals and the recovery of tissues that are known to contain a high concentration of the virus, by virus cultures in chick embryos, or by virus tissue cultures. These methods are expensive and time consuming; also the viruses may change certain of their pathogenic traits or become "fixed" or capable of attacking only certain tissues.

A procedure for preserving sera, solutions, cultures, and the like, by freezing and drying *in vacuo* was described by Flosdorf and Mudd (*1*). By a modification of the technique described by these authors, a method has been worked out whereby these viruses have been preserved in a dry state. Also, the original characteristics of one of the dried viruses (the Green strain of lymphocytic choriomeningitis

[1] From the Division of Infectious Diseases, National Institute of Health, Washington, D. C.

virus) has been maintained, whereas by serial intracerebral transfer in white mice this strain of virus had become fixed for mouse brain tissue.

## TECHNIQUE

Pieces of virus-bearing tissue that have been freshly removed are utilized. A piece of tissue, 0.3 to 0.5 gm., is placed in the bottom of a sterile pyrex test tube at least 15 mm. in diameter. The test tube is then quickly heated about 7.5 cm. from the bottom by a blast burner with a narrow flame and drawn out to a diameter of approximately 4 to 6 mm. (care must be taken that the bottom of the test tube is kept cool). The tube is then connected by means of a rubber stopper, rubber pressure tubing, and glass tubing to the manifold of the Flosdorf-Mudd apparatus. After the machine is ready for operation, the end of the tube containing the tissue is immersed in a tray of methyl cellosolve and cracked, solid carbon dioxide. After about 10 minutes, when the tissue is frozen, a vacuum of at least 0.05 mm. of mercury is induced and maintained throughout the process of drying. The end of the tube containing the virus-bearing material is kept submerged in the carbon dioxide-methyl cellosolve mixture. Cracked carbon dioxide is added to the trays at frequent intervals for 8 hours, thus keeping the temperature at about −75° C. After this time no more carbon dioxide is added and the solution in the trays slowly returns to room temperature. When the vacuum has been maintained for 22 to 24 hours, the constricted portion of the test tube is sealed off with a flame. The vacuum should be maintained until all tubes are sealed. The ampules are stored in a cold room at about 5° C.

Tested by animal inoculation lymphocytic choriomeningitis virus remained viable after 153, 260, and 378 days. Dried encephalitis (St. Louis type) virus remained viable after 361 and 833 days in storage (table 1). No failures to recover the virus in susceptible animals have resulted after preservation by this method.

TABLE 1.—*Retention of potency by virus dried in vacuo*

| Virus-bearing tissue, dried | Date dried | Number of days storage to test | Date dried virus was inoculated into animals | Animals employed and route of inoculation | Results |
|---|---|---|---|---|---|
| Lymphocytic choriomeningitis infected mouse brain. | Apr. 24, 1937 | 153 | Sept. 24, 1937 | Mice IC | Virus recovered. |
| Do | Sept. 11, 1936 | 378 | do | do | Do. |
| Lymphocytic choriomeningitis infected monkey liver, kidney, and spleen. | Apr. 28, 1937 | 260 | Jan. 13, 1937 | Monkey IC, Sub Q and IP. | Do. |
| Encephalitis, St. Louis type, infected mouse brains. | Sept. 28, 1936 | 361 | Sept. 24, 1937 | Mice IC | Do. |
| Do | Sept. 10, 1936 | 833 | Dec. 22, 1938 | do | Do. |

IC = Intracerebral.
Sub Q = Subcutaneous.
IP = Intraperitoneal.

SUMMARY

A method of freezing and drying is described by which the viruses of lymphocytic choriomeningitis and St. Louis encephalitis have been preserved for 378 and 833 days, respectively. Tests were not made at longer periods.

REFERENCE

(1) Flosdorf, Earl W., and Mudd, Stuart: Procedure and apparatus for preservation in "lyophile" form of serum and other biological substances. J. Immunol., **29:** 389–425 (November 1935).

## DEATHS DURING WEEK ENDED MAY 27, 1939

[From the Weekly Health Index, issued by the Bureau of the Census, Department of Commerce]

| | Week ended May 27, 1939 | Corresponding week, 1938 |
|---|---|---|
| Data from 88 large cities of the United States: | | |
| Total deaths | 8,019 | [1] 8,130 |
| Average for 3 prior years | [2] 8,122 | |
| Total deaths, first 21 weeks of year | 191,399 | 183,351 |
| Deaths under 1 year of age | 471 | [1] 495 |
| Average for 3 prior years | [2] 517 | |
| Deaths under 1 year of age, first 21 weeks of year | 11,185 | 11,320 |
| Data from industrial insurance companies: | | |
| Policies in force | 67,344,634 | 68,308,527 |
| Number of death claims | 12,689 | 12,038 |
| Death claims per 1,000 policies in force, annual rate | 9.8 | 9.2 |
| Death claims per 1,000 policies, first 21 weeks of year, annual rate | 11.6 | 9.9 |

[1] Data for 87 cities.
[2] Data for 86 cities.

# PREVALENCE OF DISEASE

*No health department, State or local, can effectively prevent or control disease without knowledge of when, where, and under what conditions cases are occurring*

## UNITED STATES

### CURRENT WEEKLY STATE REPORTS

These reports are preliminary, and the figures are subject to change when later returns are received by the State health officers.

In these and the following tables, a zero (0) indicates a positive report and has the same significance as any other figure, while leaders (----) represent no report, with the implication that cases or deaths may have occurred but were not reported to the State health officer.

***Cases of certain diseases reported by telegraph by State health officers for the week ended June 3, 1939, rates per 100,000 population (annual basis), and comparison with corresponding week of 1938 and 5-year median***

| Division and State | Diphtheria | | | | Influenza | | | | Measles | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | June 3, 1939, rate | June 3, 1939, cases | June 4, 1938, cases | 1934–38, median | June 3, 1939, rate | June 3, 1939, cases | June 4, 1938, cases | 1934–38, median | June 3, 1939, rate | June 3, 1939, cases | June 4, 1938, cases | 1934–38, median |
| NEW ENG. | | | | | | | | | | | | |
| Maine | 0 | 0 | 0 | 0 | ---- | ---- | ---- | ---- | 422 | 70 | 105 | 105 |
| New Hampshire | 0 | 0 | 0 | 0 | ---- | ---- | ---- | ---- | 51 | 5 | 83 | 83 |
| Vermont | 0 | 0 | 0 | 0 | ---- | ---- | ---- | ---- | 1,743 | 130 | 79 | 39 |
| Massachusetts | 2 | 2 | 2 | 5 | ---- | ---- | ---- | ---- | 1,148 | 976 | 430 | 647 |
| Rhode Island | 0 | 0 | 0 | 0 | ---- | ---- | ---- | ---- | 1,038 | 136 | 7 | 40 |
| Connecticut | 0 | 0 | 0 | 2 | 3 | 1 | 3 | 1 | 1,718 | 579 | 97 | 183 |
| MID. ATL. | | | | | | | | | | | | |
| New York [2] | 8 | 20 | 17 | 35 | 14 | 16 | 12 | 14 | 861 | 2,150 | 3,498 | 2,430 |
| New Jersey [2] | 14 | 12 | 7 | 9 | ---- | ---- | 5 | 5 | 43 | 36 | 724 | 724 |
| Pennsylvania [2] | 9 | 17 | 33 | 27 | ---- | ---- | ---- | ---- | 44 | 87 | 1,846 | 2,058 |
| E. NO. CEN. | | | | | | | | | | | | |
| Ohio [2] | 12 | 15 | 21 | 27 | 10 | 13 | ---- | 22 | 74 | 96 | 1,491 | 2,038 |
| Indiana | 6 | 4 | 25 | 7 | 1 | 1 | 6 | 14 | 15 | 10 | 442 | 442 |
| Illinois | 15 | 23 | 31 | 32 | 5 | 8 | 14 | 15 | 23 | 35 | 1,059 | 1,059 |
| Michigan [2] | 8 | 8 | 6 | 7 | 4 | 4 | ---- | 2 | 426 | 403 | 2,780 | 421 |
| Wisconsin | 4 | 2 | 3 | 3 | 62 | 35 | 27 | 24 | 1,306 | 743 | 2,703 | 1,481 |
| W. NO. CEN. | | | | | | | | | | | | |
| Minnesota | 4 | 2 | 4 | 6 | 4 | 2 | ---- | 1 | 419 | 216 | 375 | 279 |
| Iowa [2] | 6 | 3 | 2 | 2 | 4 | 2 | 4 | 1 | 381 | 188 | 274 | 204 |
| Missouri | 4 | 3 | 11 | 15 | ---- | ---- | 6 | 36 | 5 | 4 | 137 | 137 |
| North Dakota | 0 | 0 | 0 | 0 | 343 | 47 | 6 | 5 | 102 | 14 | 67 | 47 |
| South Dakota | 0 | 0 | 1 | 1 | 60 | 8 | ---- | ---- | 1,473 | 196 | ---- | 4 |
| Nebraska | 0 | 0 | 4 | 2 | 23 | 6 | ---- | ---- | 611 | 160 | 252 | 90 |
| Kansas | 0 | 0 | 3 | 3 | 14 | 5 | ---- | ---- | 162 | 58 | 383 | 383 |

See footnotes at end of table.

*Cases of certain diseases reported by telegraph by State health officers for the week ended June 3, 1939, rates per 100,000 population (annual basis), and comparison with corresponding week of 1938 and 5-year median*—Continued

| Division and State | Diphtheria | | | | Influenza | | | | Measles | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | June 3, 1939, rate | June 3, 1939, cases | June 4, 1938, cases | 1934–38, median | June 3, 1939, rate | June 3, 1939, cases | June 4, 1938, cases | 1934–38, median | June 3, 1939, rate | June 3, 1939, cases | June 4, 1938, cases | 1934–38, median |
| **SO. ATL.** | | | | | | | | | | | | |
| Delaware | 0 | 0 | 0 | 0 | | | | | 708 | 36 | 7 | 17 |
| Maryland [3 4] | 6 | 2 | 1 | 4 | 19 | 6 | 2 | 2 | 398 | 129 | 16 | 259 |
| Dist. of Col. [3] | 32 | 4 | 6 | 9 | | | 2 | 1 | 2,700 | 334 | 44 | 44 |
| Virginia [3] | 28 | 15 | 5 | 9 | 163 | 87 | | | 1,872 | 999 | 607 | 380 |
| West Virginia | 19 | 7 | 4 | 7 | 11 | 4 | 27 | 11 | 19 | 7 | 339 | 161 |
| North Carolina | 10 | 7 | 7 | 7 | 1 | 1 | 1 | 2 | 671 | 459 | 948 | 309 |
| South Carolina | 8 | 3 | 2 | 2 | 514 | 188 | 77 | 77 | 41 | 15 | 128 | 65 |
| Georgia [3] | 12 | 7 | 3 | 2 | 85 | 51 | | | 176 | 106 | 153 | |
| Florida [3] | 9 | 3 | 7 | 7 | 54 | 18 | 1 | 1 | 220 | 73 | 44 | 20 |
| **E. SO. CEN.** | | | | | | | | | | | | |
| Kentucky | 7 | 4 | 10 | 6 | 3 | 2 | 3 | 5 | 19 | 11 | 126 | 126 |
| Tennessee [3] | 5 | 3 | 1 | 4 | 35 | 20 | 18 | 18 | 145 | 82 | 104 | 104 |
| Alabama [3] | 5 | 3 | 6 | 10 | 56 | 32 | 9 | 18 | 260 | 148 | 176 | 103 |
| Mississippi [3 4] | 20 | 8 | 3 | 3 | | | | | | | | |
| **W. SO. CEN.** | | | | | | | | | | | | |
| Arkansas | 5 | 2 | 3 | 3 | 119 | 48 | 8 | 12 | 69 | 28 | 180 | 19 |
| Louisiana | 24 | 10 | 4 | 8 | 10 | 4 | 4 | 5 | 191 | 79 | 27 | 32 |
| Oklahoma | 4 | 2 | 9 | 8 | 44 | 22 | 25 | 25 | 322 | 160 | 171 | 49 |
| Texas [3] | 8 | 10 | 35 | 32 | 71 | 86 | 181 | 156 | 348 | 420 | 176 | 280 |
| **MOUNTAIN** | | | | | | | | | | | | |
| Montana | 0 | 0 | 1 | 0 | 28 | 3 | | | 1,161 | 124 | 90 | 25 |
| Idaho [3] | 10 | 1 | 1 | 0 | | | | | 561 | 55 | 7 | 11 |
| Wyoming [3] | 22 | 1 | 1 | 0 | | | | | 567 | 26 | 16 | 16 |
| Colorado [3 4] | 29 | 6 | 18 | 5 | 34 | 7 | | | 727 | 151 | 178 | 178 |
| New Mexico | 0 | 0 | 1 | 2 | 12 | 1 | | 1 | 173 | 14 | 16 | 52 |
| Arizona | 0 | 0 | 2 | 2 | 331 | 27 | 21 | 21 | 159 | 13 | 16 | 33 |
| Utah [3 4] | 20 | 2 | 0 | 0 | 10 | 1 | | | 854 | 86 | 344 | 31 |
| **PACIFIC** | | | | | | | | | | | | |
| Washington | 15 | 5 | 0 | 0 | | | | | 2,396 | 777 | 20 | 192 |
| Oregon [3] | 0 | 0 | 2 | 1 | 119 | 24 | 27 | 11 | 368 | 74 | 54 | 54 |
| California [3] | 16 | 20 | 37 | 25 | 28 | 34 | 11 | 27 | 1,710 | 2,085 | 624 | 624 |
| Total | 9 | 236 | 339 | 353 | 38 | 804 | 490 | 552 | 517 | 12,783 | 21,443 | 21,443 |
| 22 weeks | 17 | 9,267 | 11,032 | 11,692 | 315 | 147,113 | 41,924 | 100,639 | 553 | 301,185 | 682,231 | 582,885 |

| Division and State | Meningitis, meningococcus | | | | Poliomyelitis | | | | Scarlet fever | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | June 3, 1939, rate | June 3, 1939, cases | June 4, 1938, cases | 1934–38, median | June 3, 1939, rate | June 3, 1939, cases | June 4, 1938, cases | 1934–38, median | June 3, 1939, rate | June 3, 1939, cases | June 4, 1938, cases | 1934–38, median |
| **NEW ENG.** | | | | | | | | | | | | |
| Maine | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 24 | 4 | 8 | 10 |
| New Hampshire | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 51 | 5 | 22 | 20 |
| Vermont | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 161 | 12 | 9 | 6 |
| Massachusetts | 2.4 | 2 | 1 | 3 | 0 | 0 | 0 | 0 | 162 | 138 | 326 | 230 |
| Rhode Island | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 61 | 8 | 26 | 23 |
| Connecticut | 0 | 0 | 0 | 0 | 3 | 1 | 0 | 0 | 104 | 35 | 73 | 73 |
| **MID. ATL.** | | | | | | | | | | | | |
| New York [3] | 2 | 5 | 1 | 6 | 0.8 | 2 | 0 | 1 | 145 | 362 | 519 | 610 |
| New Jersey [3] | 2.4 | 2 | 0 | 1 | 1.2 | 1 | 0 | 0 | 142 | 119 | 97 | 133 |
| Pennsylvania [3] | 9 | 18 | 3 | 8 | 0 | 0 | 0 | 0 | 98 | 194 | 292 | 342 |

See footnotes at end of table.

*Cases of certain diseases reported by telegraph by State health officers for the week ended June 3, 1939, rates per 100,000 population (annual basis), and comparison with corresponding week of 1938 and 5-year median*—Continued

| Division and State | Meningitis, meningococcus | | | | Poliomyelitis | | | | Scarlet fever | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | June 3, 1939, rate | June 3, 1939, cases | June 4, 1938, cases | 1934–38, median | June 3, 1939, rate | June 3, 1939, cases | June 4, 1938, cases | 1934–38, median | June 3, 1939, rate | June 3, 1939, cases | June 4, 1938, cases | 1934–38, median |
| E. NO. CEN. | | | | | | | | | | | | |
| Ohio [2] | 2.3 | 3 | 5 | 5 | 0 | 0 | 0 | 0 | 205 | 267 | 182 | 508 |
| Indiana | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 116 | 78 | 75 | 88 |
| Illinois | 2.6 | 4 | 3 | 5 | 1.3 | 2 | 0 | 0 | 182 | 277 | 320 | 412 |
| Michigan [4] | 0 | 0 | 2 | 2 | 0 | 0 | 0 | 0 | 277 | 262 | 271 | 287 |
| Wisconsin | 0 | 0 | 1 | 0 | 1.8 | 1 | 2 | 0 | 181 | 103 | 144 | 263 |
| W. NO. CEN. | | | | | | | | | | | | |
| Minnesota | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 136 | 70 | 78 | 117 |
| Iowa [2] | 2 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 91 | 45 | 64 | 68 |
| Missouri | 0 | 0 | 3 | 3 | 0 | 0 | 0 | 0 | 53 | 41 | 154 | 91 |
| North Dakota | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 15 | 2 | 33 | 33 |
| South Dakota | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 113 | 15 | 4 | 12 |
| Nebraska | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 15 | 4 | 14 | 38 |
| Kansas | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 106 | 38 | 57 | 57 |
| SO. ATL. | | | | | | | | | | | | |
| Delaware | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 98 | 5 | 3 | 2 |
| Maryland [2 4] | 3 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 46 | 15 | 48 | 43 |
| Dist. of Col. [2] | 0 | 0 | 2 | 2 | 0 | 0 | 0 | 0 | 57 | 7 | 11 | 11 |
| Virginia [2] | 0 | 0 | 1 | 2 | 0 | 0 | 0 | 0 | 36 | 19 | 23 | 20 |
| West Virginia | 2.7 | 1 | 3 | 3 | 0 | 0 | 1 | 1 | 70 | 26 | 16 | 47 |
| North Carolina | 0 | 0 | 1 | 3 | 1.5 | 1 | 2 | 2 | 19 | 13 | 13 | 14 |
| South Carolina | 8 | 3 | 2 | 1 | 60 | 22 | 0 | 0 | 14 | 5 | 5 | 4 |
| Georgia [3] | 0 | 0 | 0 | 0 | 1.7 | 1 | 0 | 0 | 10 | 6 | 2 | 2 |
| Florida [3] | 0 | 0 | 2 | 1 | 3 | 1 | 3 | 0 | 27 | 9 | 1 | 1 |
| E. SO. CEN. | | | | | | | | | | | | |
| Kentucky | 0 | 0 | 3 | 5 | 0 | 0 | 1 | 0 | 33 | 19 | 13 | 24 |
| Tennessee [3] | 1.8 | 1 | 3 | 3 | 0 | 0 | 2 | 0 | 67 | 38 | 31 | 18 |
| Alabama [3] | 5 | 3 | 5 | 3 | 1.8 | 1 | 1 | 0 | 18 | 10 | 6 | 5 |
| Mississippi [3 4] | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 3 | 1 | 2 | 2 |
| W. SO. CEN. | | | | | | | | | | | | |
| Arkansas | 2.5 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 10 | 4 | 1 | 3 |
| Louisiana | 0 | 0 | 0 | 1 | 0 | 0 | 2 | 2 | 5 | 2 | 2 | 7 |
| Oklahoma | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 20 | 10 | 21 | 19 |
| Texas [3] | 0.8 | 1 | 0 | 3 | 1.7 | 2 | 0 | 0 | 25 | 30 | 70 | 50 |
| MOUNTAIN | | | | | | | | | | | | |
| Montana | 9 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 131 | 14 | 12 | 12 |
| Idaho [2] | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 20 | 2 | 6 | 6 |
| Wyoming [2] | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 87 | 4 | 7 | 10 |
| Colorado [2 5] | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 159 | 33 | 37 | 37 |
| New Mexico | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 49 | 4 | 9 | 9 |
| Arizona | 0 | 0 | 0 | 0 | 86 | 7 | 0 | 0 | 49 | 4 | 5 | 13 |
| Utah [2 4] | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 228 | 23 | 14 | 14 |
| PACIFIC | | | | | | | | | | | | |
| Washington | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 89 | 29 | 15 | 32 |
| Oregon [2] | 0 | 0 | 1 | 1 | 5 | 1 | 0 | 0 | 55 | 11 | 19 | 25 |
| California [2] | 1.6 | 2 | 2 | 2 | 14 | 17 | 2 | 5 | 112 | 137 | 155 | 175 |
| Total | 1.9 | 49 | 51 | 96 | 2.4 | 60 | 19 | 36 | 102 | 2,559 | 3,315 | 4,470 |
| 22 weeks | 1.9 | 1,052 | 1,690 | 3,134 | 0.9 | 511 | 427 | 468 | 188 | 103,808 | 120,897 | 145,153 |

See footnotes at end of table.

*Cases of certain diseases reported by telegraph by State health officers for the week ended June 3, 1939, rates per 100,000 population (annual basis), and comparison with corresponding week of 1938 and 5-year median*—Continued

| Division and State | Smallpox | | | | Typhoid and paratyphoid fever | | | | Whooping cough | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | June 3, 1939, rate | June 3, 1939, cases | June 4, 1938, cases | 1934–38, median | June 3, 1939, rate | June 3, 1939, cases | June 4, 1938, cases | 1934–38, median | June 3, 1939, rate | June 3, 1939, cases | June 4, 1938, cases |
| NEW ENG. | | | | | | | | | | | |
| Maine | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 2 | 163 | 27 | 22 |
| New Hampshire | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | ---- |
| Vermont | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 523 | 39 | 20 |
| Massachusetts | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 3 | 128 | 109 | 143 |
| Rhode Island | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 328 | 43 | 24 |
| Connecticut | 0 | 0 | 0 | 0 | 3 | 1 | 0 | 2 | 134 | 45 | 76 |
| MID. ATL. | | | | | | | | | | | |
| New York [2] | 8 | 20 | 0 | 0 | 2 | 6 | 1 | 7 | 134 | 334 | 433 |
| New Jersey [2] | 0 | 0 | 0 | 0 | 4 | 3 | 1 | 2 | 350 | 294 | 191 |
| Pennsylvania [3] | 0 | 0 | 0 | 0 | 4 | 7 | 9 | 7 | 98 | 194 | 184 |
| E. NO. CEN. | | | | | | | | | | | |
| Ohio [2] | 22 | 28 | 69 | 0 | 12 | 16 | 8 | 7 | 130 | 169 | 133 |
| Indiana | 33 | 22 | 39 | 2 | 1 | 1 | 3 | 3 | 105 | 71 | 30 |
| Illinois | 7 | 10 | 15 | 15 | 5 | 7 | 5 | 6 | 153 | 233 | 230 |
| Michigan [4] | 7 | 7 | 1 | 1 | 1 | 1 | 6 | 5 | 172 | 163 | 257 |
| Wisconsin | 2 | 1 | 2 | 2 | 2 | 1 | 3 | 1 | 246 | 140 | 191 |
| W. NO. CEN. | | | | | | | | | | | |
| Minnesota | 33 | 17 | 16 | 16 | 2 | 1 | 1 | 1 | 83 | 43 | 45 |
| Iowa [2] | 61 | 30 | 21 | 21 | 4 | 2 | 1 | 0 | 51 | 25 | 34 |
| Missouri | 36 | 28 | 48 | 7 | 1 | 1 | 8 | 8 | 28 | 22 | 38 |
| North Dakota | 0 | 0 | 19 | 11 | 29 | 4 | 2 | 2 | 7 | 1 | 25 |
| South Dakota | 105 | 14 | 22 | 5 | 0 | 0 | 0 | 0 | 8 | 1 | 3 |
| Nebraska | 34 | 9 | 1 | 5 | 0 | 0 | 0 | 0 | 27 | 7 | 14 |
| Kansas | 17 | 6 | 23 | 13 | 0 | 0 | 1 | 2 | 78 | 28 | 134 |
| SO. ATL. | | | | | | | | | | | |
| Delaware | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 394 | 30 | 9 |
| Maryland [2 4] | 0 | 0 | 0 | 0 | 6 | 2 | 5 | 5 | 108 | 35 | 47 |
| Dist. of Col. [2] | 0 | 0 | 0 | 0 | 8 | 1 | 1 | 1 | 218 | 27 | 12 |
| Virginia [2] | 0 | 0 | 0 | 0 | 11 | 6 | 6 | 7 | 240 | 128 | 147 |
| West Virginia | 0 | 0 | 1 | 0 | 16 | 6 | 5 | 5 | 89 | 33 | 104 |
| North Carolina | 0 | 0 | 6 | 1 | 13 | 9 | 8 | 5 | 288 | 197 | 240 |
| South Carolina | 0 | 0 | 0 | 0 | 25 | 9 | 8 | 8 | 188 | 69 | 69 |
| Georgia [3] | 20 | 12 | 0 | 0 | 28 | 17 | 21 | 7 | 80 | 48 | 44 |
| Florida [3] | 0 | 0 | 0 | 0 | 6 | 2 | 9 | 2 | 142 | 47 | 20 |
| E. SO. CEN. | | | | | | | | | | | |
| Kentucky | 2 | 1 | 2 | 0 | 9 | 5 | 4 | 6 | 26 | 15 | 43 |
| Tennessee [3] | 97 | 55 | 1 | 1 | 16 | 9 | 9 | 8 | 123 | 70 | 66 |
| Alabama [3] | 0 | 0 | 0 | 0 | 18 | 10 | 13 | 5 | 190 | 108 | 26 |
| Mississippi [3 4] | 0 | 0 | 1 | 0 | 8 | 3 | 6 | 4 | ---- | ---- | ---- |
| W. SO. CEN. | | | | | | | | | | | |
| Arkansas | 12 | 5 | 13 | 2 | 27 | 11 | 16 | 6 | 50 | 20 | 41 |
| Louisiana | 0 | 0 | 1 | 0 | 24 | 10 | 11 | 10 | 15 | 6 | 10 |
| Oklahoma | 80 | 40 | 32 | 4 | 14 | 7 | 11 | 6 | 6 | 3 | 60 |
| Texas [3] | 6 | 7 | 34 | 24 | 10 | 12 | 34 | 24 | 107 | 129 | 373 |
| MOUNTAIN | | | | | | | | | | | |
| Montana | 19 | 2 | 5 | 5 | 0 | 0 | 1 | 1 | 56 | 6 | 43 |
| Idaho [2] | 0 | 0 | 5 | 1 | 0 | 0 | 1 | 0 | 71 | 7 | 5 |
| Wyoming [2] | 0 | 0 | 0 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 10 |
| Colorado [2 5] | 29 | 6 | 4 | 3 | 5 | 1 | 7 | 0 | 135 | 28 | 21 |
| New Mexico | 12 | 1 | 0 | 0 | 0 | 0 | 0 | 2 | 222 | 18 | 12 |
| Arizona | 37 | 3 | 9 | 0 | 12 | 1 | 3 | 3 | 61 | 5 | 24 |
| Utah [2 4] | 10 | 1 | 0 | 0 | 30 | 3 | 0 | 0 | 467 | 47 | 80 |
| PACIFIC | | | | | | | | | | | |
| Washington | 9 | 3 | 22 | 3 | 86 | 28 | 1 | 1 | 49 | 16 | 113 |
| Oregon [2] | 35 | 7 | 28 | 2 | 0 | 0 | 3 | 3 | 85 | 17 | 38 |
| California [3] | 2 | 2 | 18 | 8 | 6 | 7 | 7 | 7 | 148 | 181 | 421 |
| Total | 13 | 337 | 458 | 198 | 8 | 210 | 244 | 197 | 132 | 3,268 | 4,395 |
| 22 weeks | 14 | 7,649 | 10,894 | 4,855 | 5 | 2,720 | 2,966 | 2,966 | 160 | 87,076 | 94,258 |

[1] New York City only.
[2] Rocky Mountain spotted fever, week ended June 3, 1939, 26 cases as follows: New York, 1; New Jersey, 2; Ohio, 3; Iowa, 2; Maryland, 1; District of Columbia, 2; Virginia, 4; Idaho, 1; Wyoming, 3; Colorado, 3; Utah, 2; Oregon, 2.
[3] Typhus fever, week ended June 3, 1939, 48 cases as follows: Pennsylvania, 1; Georgia, 17; Florida, 4; Tennessee, 5; Alabama, 9; Mississippi, 3; Texas, 8; California, 1.
[4] Period ended earlier than Saturday.
[5] Colorado tick fever, week ended June 3, 1939, Colorado, 15 cases.

## SUMMARY OF MONTHLY REPORTS FROM STATES

The following summary of cases reported monthly by States is published weekly and covers only those States from which reports are received during the current week.

| State | Meningitis, meningococcus | Diphtheria | Influenza | Malaria | Measles | Pellagra | Poliomyelitis | Scarlet fever | Smallpox | Typhoid and paratyphoid fever |
|---|---|---|---|---|---|---|---|---|---|---|
| *March 1939* | | | | | | | | | | |
| Puerto Rico | 0 | 40 | 154 | 2,362 | 9 | 3 | 0 | 0 | 0 | 41 |
| *April 1939* | | | | | | | | | | |
| Wisconsin | 2 | 1 | 449 | | 2,901 | | 1 | 734 | 5 | 1 |
| *May 1939* | | | | | | | | | | |
| Missouri | 2 | 16 | 4 | 4 | 41 | | 0 | 268 | 148 | 4 |

*March 1939*

| Puerto Rico: | Cases |
|---|---|
| Chickenpox | 66 |
| Dysentery | 7 |
| Leprosy | 2 |
| Mumps | 5 |
| Ophthalmia neonatorum | 4 |
| Puerperal septicemia | 7 |
| Tetanus | 8 |
| Tetanus, infantile | 2 |
| Whooping cough | 180 |

*April 1939*

| Wisconsin: | Cases |
|---|---|
| Chickenpox | 1,196 |
| Encephalitis, epidemic or lethargic | 1 |
| German measles | 89 |
| Mumps | 1,075 |
| Septic sore throat | 27 |
| Undulant fever | 10 |
| Whooping cough | 655 |

*May 1939*

| Missouri: | Cases |
|---|---|
| Chickenpox | 171 |
| Dysentery (bacillary) | 3 |
| Mumps | 327 |
| Rabies in man | 3 |
| Septic sore throat | 18 |
| Tetanus | 1 |
| Trachoma | 48 |
| Tularaemia | 3 |
| Whooping cough | 78 |

## PLAGUE INFECTION IN CALIFORNIA AND OREGON

### IN A GROUND SQUIRREL IN VENTURA COUNTY, CALIF.

Under date of May 26, 1939, Dr. W. M. Dickie, State Director of Public Health of California, reported plague infection proved in a ground squirrel, *C. beecheyi*, submitted to the laboratory on April 26 from a location 5 miles north of Ventura, in Mills Canyon, Ventura County, Calif.

### IN FLEAS FROM GROUND SQUIRRELS IN GRANT COUNTY, OREG.

Under date of May 29, 1939, Senior Surg. C. R. Eskey reported plague infection proved in a pool of 13 fleas from 28 ground squirrels, *C. oregonus*, shot May 10 at localities 1 to 4 miles south of Mount Vernon, Grant County, Oreg.

## WEEKLY REPORTS FROM CITIES

*City reports for week ended May 27, 1939*

This table summarizes the reports received weekly from a selected list of 140 cities for the purpose of showing a cross section of the current urban incidence of the communicable diseases listed in the table.

| State and city | Diphtheria cases | Influenza | | Measles cases | Pneumonia deaths | Scarlet fever cases | Smallpox cases | Tuberculosis deaths | Typhoid fever cases | Whooping cough cases | Deaths, all causes |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Cases | Deaths | | | | | | | | |
| Data for 90 cities: | | | | | | | | | | | |
| 5-year average | 154 | 72 | 32 | 6,059 | 562 | 1,963 | 17 | 406 | 32 | 1,341 | ---- |
| Current week [1] | 100 | 90 | 33 | 4,171 | 400 | 1,232 | 25 | 341 | 32 | 1,130 | ---- |
| Maine: | | | | | | | | | | | |
| Portland | 0 | ---- | 0 | 0 | 2 | 1 | 0 | 0 | 0 | 9 | 18 |
| New Hampshire: | | | | | | | | | | | |
| Concord | 0 | ---- | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 10 |
| Manchester | 0 | ---- | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 9 |
| Nashua | 0 | ---- | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 6 |
| Vermont: | | | | | | | | | | | |
| Barre | 0 | ---- | ---- | 0 | ---- | 1 | 0 | ---- | 0 | 14 | ---- |
| Burlington | 0 | ---- | 0 | 9 | 0 | 0 | 0 | 0 | 0 | 4 | 7 |
| Rutland | 0 | ---- | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 8 |
| Massachusetts: | | | | | | | | | | | |
| Boston | 2 | ---- | 0 | 201 | 27 | 56 | 0 | 8 | 0 | 26 | 203 |
| Fall River | 1 | ---- | 0 | 3 | 1 | 4 | 0 | 0 | 0 | 0 | 32 |
| Springfield | 0 | ---- | 0 | 14 | 1 | 1 | 0 | 0 | 0 | 2 | 27 |
| Worcester | 0 | ---- | 0 | 22 | 5 | 2 | 0 | 2 | 0 | 16 | 52 |
| Rhode Island: | | | | | | | | | | | |
| Pawtucket | 0 | ---- | 0 | 33 | 3 | 1 | 0 | 0 | 0 | 2 | 3 |
| Providence | 0 | 35 | 0 | 66 | 5 | 6 | 0 | 3 | 1 | 34 | 61 |
| Connecticut: | | | | | | | | | | | |
| Bridgeport | 0 | ---- | 1 | 15 | 3 | 2 | 0 | 1 | 0 | 1 | 30 |
| Hartford | 0 | ---- | 0 | 22 | 2 | 4 | 0 | 3 | 0 | 7 | 40 |
| New Haven | 0 | ---- | 1 | 297 | 1 | 6 | 0 | 1 | 1 | 10 | 36 |
| New York: | | | | | | | | | | | |
| Buffalo | 0 | ---- | 1 | 135 | 10 | 45 | 0 | 4 | 0 | 11 | 163 |
| New York | 19 | 8 | 2 | 218 | 48 | 217 | 0 | 60 | 6 | 117 | 1,396 |
| Rochester | 0 | 2 | 0 | 183 | 2 | 19 | 0 | 2 | 1 | 6 | 69 |
| Syracuse | 0 | ---- | 0 | 255 | 2 | 4 | 0 | 0 | 0 | 21 | 33 |
| New Jersey: | | | | | | | | | | | |
| Camden | 1 | ---- | 0 | 0 | 0 | 5 | 0 | 0 | 0 | 1 | 26 |
| Newark | 0 | 2 | 0 | 2 | 4 | 61 | 0 | 9 | 0 | 57 | 100 |
| Trenton | 0 | ---- | 0 | 0 | 4 | 15 | 0 | 0 | 0 | 2 | 46 |
| Pennsylvania: | | | | | | | | | | | |
| Philadelphia | 5 | 2 | 2 | 61 | 25 | 26 | 0 | 26 | 1 | 93 | 479 |
| Pittsburgh | 3 | ---- | 1 | 1 | 15 | 24 | 0 | 10 | 2 | 32 | 154 |
| Reading | 0 | ---- | 0 | 15 | 0 | 0 | 0 | 1 | 0 | 0 | 24 |
| Scranton | 0 | ---- | ---- | 0 | ---- | 8 | 0 | ---- | 0 | 1 | ---- |
| Ohio: | | | | | | | | | | | |
| Cincinnati | 3 | ---- | 5 | 2 | 8 | 25 | 0 | 3 | 0 | 1 | 115 |
| Cleveland | 4 | 10 | 0 | 8 | 12 | 64 | 0 | 13 | 0 | 54 | 188 |
| Columbus | 0 | ---- | 0 | 4 | 2 | 3 | 0 | 2 | 0 | 13 | 101 |
| Toledo | 0 | ---- | 0 | 24 | 3 | 17 | 2 | 2 | 0 | 39 | 65 |
| Indiana: | | | | | | | | | | | |
| Anderson | 0 | ---- | 0 | 0 | 1 | 2 | 0 | 0 | 0 | 4 | 13 |
| Fort Wayne | 0 | ---- | 0 | 0 | 0 | 4 | 0 | 0 | 0 | 0 | 17 |
| Indianapolis | 1 | ---- | 0 | 1 | 7 | 33 | 6 | 3 | 1 | 44 | 89 |
| Muncie | 0 | ---- | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 10 |
| South Bend | 0 | ---- | 0 | 1 | 1 | 1 | 0 | 0 | 0 | 34 | 19 |
| Terre Haute | 0 | ---- | 0 | 0 | 4 | 0 | 0 | 0 | 0 | 0 | 37 |
| Illinois: | | | | | | | | | | | |
| Alton | 0 | ---- | 0 | 0 | 1 | 2 | 0 | 0 | 0 | 0 | 10 |
| Chicago | 16 | 2 | 2 | 14 | 19 | 194 | 2 | 40 | 1 | 107 | 665 |
| Elgin | 0 | ---- | 1 | 1 | 0 | 1 | 0 | 0 | 0 | 5 | 10 |
| Moline | 0 | ---- | ---- | 0 | ---- | 0 | 0 | ---- | 0 | 3 | ---- |
| Springfield | 0 | ---- | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 5 | 19 |
| Michigan: | | | | | | | | | | | |
| Detroit | 6 | ---- | 0 | 29 | 11 | 103 | 0 | 9 | 1 | 89 | 249 |
| Flint | 0 | ---- | 1 | 28 | 4 | 22 | 0 | 0 | 0 | 1 | 34 |
| Grand Rapids | 0 | ---- | 0 | 2 | 0 | 37 | 0 | 1 | 0 | 0 | 30 |
| Wisconsin: | | | | | | | | | | | |
| Kenosha | 0 | ---- | 0 | 0 | 0 | 3 | 0 | 0 | 0 | 4 | 11 |
| Madison | 0 | ---- | 0 | 153 | 0 | 1 | 0 | 0 | 0 | 11 | 13 |
| Milwaukee | 0 | ---- | 0 | 3 | 3 | 33 | 0 | 7 | 0 | 31 | 101 |
| Racine | 0 | ---- | 0 | 2 | 1 | 1 | 0 | 0 | 0 | 5 | 11 |
| Superior | 0 | ---- | 0 | 10 | 0 | 2 | 0 | 0 | 0 | 1 | 6 |

[1] Figures for Little Rock and Houston estimated; reports not received.

*City reports for week ended May 27, 1939*—Continued

| State and city | Diphtheria cases | Influenza | | Measles cases | Pneumonia deaths | Scarlet fever cases | Smallpox cases | Tuberculosis deaths | Typhoid fever cases | Whooping cough cases | Deaths, all causes |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Cases | Deaths | | | | | | | | |
| **Minnesota:** | | | | | | | | | | | |
| Duluth | 0 | ------ | 0 | 0 | 2 | 0 | 0 | 3 | 0 | 2 | 27 |
| Minneapolis | 0 | ------ | 1 | 79 | 3 | 10 | 0 | 2 | 0 | 26 | 93 |
| St. Paul | 0 | 1 | 1 | 50 | 5 | 6 | 0 | 0 | 0 | 13 | 62 |
| **Iowa:** | | | | | | | | | | | |
| Cedar Rapids | 0 | ------ | ------ | 7 | ------ | 1 | 0 | ------ | 0 | 0 | ------ |
| Davenport | 0 | ------ | ------ | 0 | ------ | 1 | 5 | ------ | 0 | 0 | ------ |
| Des Moines | 0 | ------ | 0 | 1 | 0 | 20 | 4 | 0 | 0 | 0 | 40 |
| Sioux City | 0 | ------ | ------ | 7 | ------ | 4 | 0 | ------ | 0 | 12 | ------ |
| Waterloo | 2 | ------ | ------ | 1 | ------ | 9 | 0 | ------ | 0 | 1 | ------ |
| **Missouri:** | | | | | | | | | | | |
| Kansas City | 2 | ------ | 1 | 4 | 8 | 13 | 0 | 4 | 0 | 2 | 96 |
| St. Joseph | 0 | ------ | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 27 |
| St. Louis | 2 | ------ | 1 | 2 | 8 | 20 | 0 | 8 | 1 | 19 | 191 |
| **North Dakota:** | | | | | | | | | | | |
| Fargo | 0 | ------ | 0 | 3 | 1 | 0 | 0 | 0 | 0 | 0 | 9 |
| Grand Forks | 0 | ------ | ------ | 0 | ------ | 0 | 0 | ------ | 0 | 0 | ------ |
| Minot | 0 | ------ | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 2 |
| **South Dakota:** | | | | | | | | | | | |
| Aberdeen | 0 | ------ | ------ | 235 | ------ | 0 | 12 | ------ | 0 | 0 | ------ |
| Sioux Falls | 0 | ------ | 0 | 1 | 0 | 3 | 6 | 0 | 0 | 0 | 4 |
| **Nebraska:** | | | | | | | | | | | |
| Lincoln | 0 | ------ | ------ | 66 | ------ | 2 | 0 | ------ | 0 | 15 | ------ |
| Omaha | 1 | ------ | 0 | 3 | 3 | 3 | 3 | 0 | 1 | 2 | 49 |
| **Kansas:** | | | | | | | | | | | |
| Lawrence | 0 | ------ | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 5 |
| Topeka | 0 | ------ | 0 | 1 | 3 | 2 | 6 | 1 | 0 | 2 | 18 |
| Wichita | 0 | ------ | 0 | 8 | 3 | 1 | 0 | 0 | 1 | 9 | 22 |
| **Delaware:** | | | | | | | | | | | |
| Wilmington | 0 | ------ | 0 | 12 | 2 | 1 | 0 | 1 | 0 | 0 | 25 |
| **Maryland:** | | | | | | | | | | | |
| Baltimore | 2 | 2 | 1 | 67 | 6 | 19 | 0 | 14 | 1 | 26 | 201 |
| Cumberland | 0 | ------ | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 6 |
| Frederick | 0 | ------ | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 |
| **Dist. of Col.:** | | | | | | | | | | | |
| Washington | 3 | ------ | 0 | 316 | 19 | 13 | 0 | 13 | 1 | 27 | 169 |
| **Virginia:** | | | | | | | | | | | |
| Lynchburg | 1 | ------ | 0 | 71 | 1 | 0 | 0 | 1 | 0 | 22 | 14 |
| Norfolk | 3 | 1 | 0 | 39 | 1 | 2 | 0 | 1 | 0 | 3 | 33 |
| Richmond | 1 | ------ | 2 | 342 | 3 | 1 | 0 | 0 | 0 | 0 | 45 |
| Roanoke | 0 | ------ | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 2 | 16 |
| **West Virginia:** | | | | | | | | | | | |
| Charleston | 0 | ------ | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 11 |
| Huntington | 2 | ------ | ------ | 0 | ------ | 1 | 0 | ------ | 0 | 0 | ------ |
| Wheeling | 0 | ------ | 0 | 1 | 1 | 1 | 0 | 0 | 0 | 10 | 22 |
| **North Carolina:** | | | | | | | | | | | |
| Gastonia | 0 | ------ | ------ | 0 | ------ | 0 | 0 | ------ | 0 | 0 | ------ |
| Raleigh | 1 | ------ | 0 | 3 | 1 | ------ | 0 | 0 | 0 | 0 | 12 |
| Wilmington | 0 | ------ | 0 | 1 | 2 | 0 | 0 | 0 | 0 | 0 | 9 |
| Winston-Salem | 0 | ------ | 0 | 5 | 1 | 1 | 0 | 4 | 0 | 1 | 27 |
| **South Carolina:** | | | | | | | | | | | |
| Charleston | 0 | 2 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 6 | 20 |
| Greenville | 0 | ------ | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 4 |
| **Georgia:** | | | | | | | | | | | |
| Atlanta | 1 | 7 | 2 | 1 | 2 | 1 | 0 | 4 | 1 | 1 | 79 |
| Brunswick | 0 | ------ | 0 | 6 | 0 | 1 | 0 | 0 | 0 | 0 | 3 |
| Savannah | 0 | 2 | 0 | 0 | 2 | 0 | 0 | 2 | 0 | 8 | 24 |
| **Florida:** | | | | | | | | | | | |
| Miami | 1 | 2 | 0 | 1 | 1 | 1 | 0 | 2 | 1 | 3 | 31 |
| Tampa | 0 | 1 | 1 | 31 | 4 | 1 | 0 | 0 | 0 | 4 | 22 |
| **Kentucky:** | | | | | | | | | | | |
| Ashland | 0 | ------ | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 5 |
| Covington | 0 | ------ | 0 | 0 | 1 | 2 | 0 | 3 | 0 | 0 | 13 |
| Lexington | 0 | ------ | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 17 |
| Louisville | 0 | 1 | 0 | 4 | 5 | 9 | 0 | 1 | 0 | 6 | 88 |
| **Tennessee:** | | | | | | | | | | | |
| Knoxville | 0 | 1 | 1 | 0 | 0 | 2 | 0 | 0 | 1 | 0 | 17 |
| Memphis | 0 | ------ | 3 | 2 | 3 | 12 | 0 | 5 | 1 | 15 | 76 |
| Nashville | 0 | ------ | 1 | 0 | 2 | 7 | 0 | 1 | 0 | 1 | 55 |
| **Alabama:** | | | | | | | | | | | |
| Birmingham | 0 | 1 | 0 | 1 | 2 | 1 | 0 | 1 | 0 | 6 | 56 |
| Mobile | 0 | 3 | 0 | 24 | 3 | 0 | 0 | 0 | 0 | 1 | 24 |
| Montgomery | 0 | ------ | ------ | 1 | ------ | 1 | 0 | ------ | 0 | 2 | ------ |

*City reports for week ended May 27, 1939*—Continued

| State and city | Diphtheria cases | Influenza | | Measles cases | Pneumonia deaths | Scarlet fever cases | Smallpox cases | Tuberculosis deaths | Typhoid fever cases | Whooping cough cases | Deaths, all causes |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Cases | Deaths | | | | | | | | |
| Arkansas: | | | | | | | | | | | |
| Fort Smith | 1 | | | 5 | | 1 | 0 | | 0 | 0 | |
| Little Rock | | | | | | | | | | | |
| Louisiana: | | | | | | | | | | | |
| Lake Charles | 0 | | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 7 |
| New Orleans | 2 | 1 | 1 | 27 | 7 | 7 | 0 | 11 | 2 | 1 | 130 |
| Shreveport | 1 | | 0 | 6 | 6 | 1 | 0 | 2 | 0 | 1 | 40 |
| Oklahoma: | | | | | | | | | | | |
| Oklahoma City | 0 | 2 | 0 | 3 | 4 | 3 | 1 | 0 | 0 | 0 | 47 |
| Tulsa | 0 | | | 30 | | 2 | 0 | | 0 | 0 | |
| Texas: | | | | | | | | | | | |
| Dallas | 3 | | 0 | 30 | 4 | 1 | 0 | 2 | 0 | 0 | 72 |
| Fort Worth | 0 | 1 | 0 | 15 | 0 | 1 | 0 | 3 | 0 | 3 | 31 |
| Galveston | 0 | | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 15 |
| Houston | | | | | | | | | | | |
| San Antonio | 0 | | 2 | 0 | 3 | 0 | 0 | 4 | 0 | 0 | 69 |
| Montana: | | | | | | | | | | | |
| Billings | 0 | | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 11 |
| Great Falls | 0 | | 0 | 120 | 1 | 0 | 0 | 0 | 0 | 0 | 9 |
| Helena | 0 | | | 0 | | 0 | 0 | | 0 | 0 | |
| Missoula | 0 | | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 12 |
| Idaho: | | | | | | | | | | | |
| Boise | 0 | | 0 | 8 | 1 | 0 | 0 | 0 | 0 | 1 | |
| Colorado: | | | | | | | | | | | |
| Colorado Springs | 0 | | 0 | 4 | 2 | 5 | 0 | 1 | 0 | 1 | 17 |
| Denver | 5 | | 0 | 57 | 2 | 22 | 0 | 5 | 0 | 23 | 87 |
| Pueblo | 0 | | 0 | 90 | 0 | 0 | 0 | 0 | 0 | 13 | 9 |
| New Mexico: | | | | | | | | | | | |
| Albuquerque | 0 | | 0 | 0 | 1 | 1 | 0 | 2 | 0 | 0 | 11 |
| Utah: | | | | | | | | | | | |
| Salt Lake City | 0 | | 0 | 3 | 0 | 8 | 0 | 2 | 0 | 13 | 33 |
| Washington: | | | | | | | | | | | |
| Seattle | 1 | | 0 | 517 | 5 | 4 | 0 | 3 | 2 | 2 | 63 |
| Spokane | 0 | | 0 | 126 | 2 | 1 | 0 | 0 | 0 | 0 | 39 |
| Tacoma | 1 | | 0 | 16 | 2 | 0 | 2 | 0 | 0 | 0 | 35 |
| Oregon: | | | | | | | | | | | |
| Portland | 0 | | 0 | 3 | 0 | 3 | 0 | 1 | 0 | 4 | 69 |
| Salem | 0 | | | 0 | | 0 | 0 | | 0 | 0 | |
| California: | | | | | | | | | | | |
| Los Angeles | 11 | 9 | 0 | 403 | 21 | 37 | 0 | 18 | 1 | 29 | 318 |
| Sacramento | 0 | | 0 | 67 | 1 | 1 | 6 | 1 | 0 | 1 | 36 |
| San Francisco | 0 | | 0 | 22 | 8 | 10 | 0 | 12 | 4 | 10 | 160 |

| State and city | Meningitis, meningococcus | | Poliomyelitis cases | State and city | Meningitis, meningococcus | | Poliomyelitis cases |
|---|---|---|---|---|---|---|---|
| | Cases | Deaths | | | Cases | Deaths | |
| Massachusetts: | | | | Wisconsin: | | | |
| Springfield | 1 | 0 | 0 | Kenosha | 0 | 0 | 1 |
| Worcester | 1 | 0 | 0 | Milwaukee | 1 | 0 | 0 |
| New York: | | | | South Carolina: | | | |
| Buffalo | 0 | 1 | 0 | Charleston | 0 | 0 | 9 |
| New York | 1 | 0 | 1 | Georgia: | | | |
| Pennsylvania: | | | | Atlanta | 0 | 0 | 1 |
| Philadelphia | 2 | 0 | 0 | Kentucky: | | | |
| Illinois: | | | | Lexington | 1 | 0 | 0 |
| Moline | 0 | 0 | 1 | Colorado: | | | |
| | | | | Denver | 1 | 1 | 0 |

*Encephalitis, epidemic or lethargic.*—Cases: New York, 1; St. Paul, 1; Cumberland, 1.
*Pellagra.*—Cases: Winston-Salem, 3; Atlanta, 1; Savannah, 3; Miami, 1; New Orleans, 1; San Francisco, 1.
*Typhus fever.*—Cases: New York, 1; Brunswick, 1; Montgomery, 1; New Orleans, 1.

# FOREIGN AND INSULAR

## CANADA

*Provinces—Communicable diseases—Week ended May 13, 1939.*—During the week ended May 13, 1939, cases of certain communicable diseases were reported by the Department of Pensions and National Health of Canada as follows:

| Disease | Prince Edward Island | Nova Scotia | New Brunswick | Quebec | Ontario | Manitoba | Saskatchewan | Alberta | British Columbia | Total |
|---|---|---|---|---|---|---|---|---|---|---|
| Cerebrospinal meningitis | | | | 1 | 2 | 1 | | | | 4 |
| Chickenpox | | 16 | | 153 | 146 | 13 | 12 | 1 | 49 | 390 |
| Diphtheria | | 7 | 2 | 31 | 4 | 9 | 3 | | | 56 |
| Dysentery | | | | 4 | 2 | | | | | 6 |
| Influenza | | 30 | | | 307 | | 3 | | 178 | 518 |
| Lethargic encephalitis | | | | | 3 | | | | | 3 |
| Measles | | 24 | | 231 | 726 | 8 | | 16 | 6 | 1,011 |
| Mumps | | | | 37 | 99 | 50 | | 1 | 4 | 191 |
| Pneumonia | | 12 | | | 45 | | | 1 | 11 | 69 |
| Poliomyelitis | | 1 | | | | | | 2 | | 3 |
| Scarlet fever | | 4 | 17 | 68 | 120 | 31 | 10 | 18 | 6 | 274 |
| Tuberculosis | 2 | 1 | 16 | 126 | 54 | 6 | 4 | 3 | | 212 |
| Typhoid and paratyphoid fever | | | 1 | 20 | 2 | 14 | | 1 | | 38 |
| Whooping cough | | 14 | 2 | 72 | 170 | 7 | 41 | 31 | 72 | 409 |

## CUBA

*Provinces—Notifiable diseases—4 weeks ended April 1, 1939.*—During the 4 weeks ended April 1, 1939, cases of certain notifiable diseases were reported in the Provinces of Cuba as follows:

| Disease | Pinar del Rio | Habana | Matanzas | Santa Clara | Camaguey | Oriente | Total |
|---|---|---|---|---|---|---|---|
| Cancer | 2 | 1 | | 6 | | 3 | 12 |
| Chickenpox | | 5 | 1 | | 1 | 2 | 9 |
| Diphtheria | 3 | 23 | 3 | 2 | 1 | 2 | 34 |
| Leprosy | 1 | | | | | 2 | 3 |
| Malaria | 24 | 6 | 1 | 9 | 6 | 40 | 86 |
| Measles | | | | 3 | | 1 | 4 |
| Scarlet fever | | 2 | | | | | 2 |
| Trachoma | | | | | | 1 | 1 |
| Tuberculosis | 15 | 19 | 36 | 64 | 10 | 61 | 205 |
| Typhoid fever | 8 | 70 | 12 | 33 | 14 | 14 | 151 |

## SWITZERLAND

*Communicable diseases—March 1939.*—During the month of March 1939, cases of certain communicable diseases were reported in Switzerland as follows:

| Disease | Cases | Disease | Cases |
|---|---|---|---|
| Cerebrospinal meningitis | 5 | Mumps | 170 |
| Chickenpox | 142 | Paratyphoid fever | 5 |
| Diphtheria | 69 | Scarlet fever | 382 |
| German measles | 15 | Tuberculosis | 315 |
| Influenza | 4,641 | Typhoid fever | 5 |
| Lethargic encephalitis | 2 | Undulant fever | 12 |
| Measles | 18 | Whooping cough | 78 |

## CHOLERA, PLAGUE, SMALLPOX, TYPHUS FEVER, AND YELLOW FEVER

NOTE.—A table giving current information of the world prevalence of quarantinable diseases appeared in the PUBLIC HEALTH REPORTS for May 26, 1939, pages 906–918. A similar cumulative table will appear in future issues of the PUBLIC HEALTH REPORTS for the last Friday of each month.

### Cholera

*China—Macao.*—During the week ended May 27, 1939, 10 cases of cholera were reported in Macao, China.

*India—Allahabad.*—During the week ended May 27, 1939, 1 case of cholera was reported in Allahabad, India.

### Plague

*Belgian Congo—Virakwa—Drodro.*—During the week ended May 27, 1939, 11 cases of plague were reported in Drodro, Virakwa, Belgian Congo.

*China—Manchuria—Hsinking.*—According to information dated May 5, 1939, 34 cases of plague have occurred in Hsinking, Manchuria, since the beginning of the year, as compared with 17 cases in the first 4 months of 1938. Only 8 deaths have been reported and all preventive measures have been taken.

*Hawaii Territory—Island of Hawaii—Hamakua District—Kapulena.*—Two rats found on May 6, 1939, in the Kapulena area, Hamakua District, Island of Hawaii, Hawaii Territory, have been proved positive for plague.

*United States.*—A report of plague infection in Ventura County, Calif., and in Grant County, Oreg., appears on page 1084 of this issue of the PUBLIC HEALTH REPORTS.

### Typhus Fever

*Venezuela—Bolivar State—Bolivar.*—During the period April 16–30, 1939, 1 case of typhus fever was reported in Bolivar, Bolivar State, Venezuela.

### Yellow Fever

*Ivory Coast.*—On May 25, 1939, yellow fever was reported in Ivory Coast as follows: Arra region, 1 case; Tranin Plantation near Man, 1 case.

*French West Africa—Niger—Tahua.*—On May 24, 1939, 1 case of yellow fever was reported in Tahua, Niger, French West Africa.

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